Supporting Information for:

SHEDS-HT: An Integrated Probabilistic Exposure Model for Prioritizing Exposures to Near-Field and Dietary Chemicals: Supporting Information

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A. SHEDS-HT Exposure Equations and Input Data

SHEDS-HT combines human activity data with predicted indoor concentrations, consumer product use patterns, and exposure factors to generate exposures for a stochastically-generated set of simulated individuals. The SHEDS-HT exposure methods were developed in large part based on the exposure algorithms of SHEDS-Multimedia (SHEDS-MM; Glen et al. 2012). This section describes the exposure algorithms and methodologies of SHEDS-HT.

Exposure results when a person encounters the specified chemical agent either through direct use, via indoor environmental media or through dietary intake. SHEDS-HT calculates exposure to chemicals with both direct and indirect near-field sources (pathways). The equations and algorithms used in the model and the values of any parameters used are described below. The default input databases required by SHEDS-HT are described in Table S1, while specific input model parameter values and sources are given in Tables S2 and S3. Consumer product category-specific input parameters and sources are given in Section E.

Activity Diaries

SHEDS-HT defines a set of microenvironments (hereafter called "micros"), to determine the simulated person's surroundings and the amount of chemical present. The model uses summaries of CHAD activity diaries to determine the amount of time spent in each micro by the simulated person. The exposures in SHEDS-HT depend in some instances on the amount of time spent in the micro. Each activity diary in the SHEDS-HT input database contains a summary of the time spent in a number of defined exposure-relevant including residences, vehicles, work locations, and outdoors. A corresponding average ventilation rate, determined from a time-weighted average of the metabolic equivalents (McCurdy et al. 2000) of the activities reported on the original CHAD diary, is also included on the diary for use in calculation of inhalation exposure.

Direct Pathway Exposure Methods

SHEDS-HT calculates direct exposures for every chemical and consumer product category in the input databases having a corresponding direct scenario using the equations below. Values for the consumer product category-dependent parameters in the below equations are given in Section E (Table S8).

For each simulated individual, exposure via the direct pathway (dermal route) is calculated as

$$E_{D,derm} = U_1 \times U_2 \times \text{prob}\left(\frac{FR}{365}\right) \times M \times F_{comp} \times F_{cont} \times F_{ret} \times 1E6 \quad \text{(a1)}$$

$E_{D,derm}$ is the effective dermal exposure in μg on the simulated day. F_{comp} is the mass fraction of chemical in the applied product, F_{cont} is the fraction of the mass of the product used that comes in contact with the skin, and F_{ret} is the fraction of product retained on the skin after the direct use event (i.e. not washed off). F_{cont} and F_{ret} are product category dependent. U_1 is either zero or one, based on a Bernoulli (binomial) sample using the consumer product usage prevalence (PR), which is the fraction of the population using the product. U_2 is analogous to U_1, but based on the chemical prevalence within the consumer product category (PR_{chem}), which is the fraction of the product formulations in this category containing the chemical. In the case study presented in this work, PR_{chem} is assumed to be 1 for all categories and chemicals and thus U_2 is 1. FR is the usage frequency, expressed as the average number of uses per year, for users. M is the mass of the given product applied on a usage day (g); 1E6 converts g to

μg. The prob function (which stands for probabilistic rounding) takes one or more real arguments and randomly selects one of the integers on either side of the value, using the distance to the integers as weights. For example, if the argument is 0.7, then prob(0.7) returns a value of one 70% of the time, and a value of zero the other 30% of the time. Thus the prob function determines the number of product usage events on the modeled day.

Exposure for the ingestion route of the direct pathway $E_{D,ing}$, (μg) is:

$$E_{D,ing} = U_1 \times U_2 \times prob\left(\frac{FR}{365}\right) \times M \times F_{comp} \times F_{ing} \times 1E6 \quad (a2)$$

The only difference between this equation and the above dermal equation is the replacement of F_{ret} and F_{cont} by F_{ing}, the fraction of the applied product mass that is ingested.

For the inhalation of vapor scenario, SHEDS-HT calculates an estimate of the evaporation amount from estimated chemical properties. It is assumed that the evaporation rate is proportional to the vapor pressure (VP), a refinement of an instantaneous release assumption. A standard is set for this by assuming that a chemical with a VP equal to total atmospheric pressure would fully evaporate in one minute (if there was enough air to avoid saturation). The air concentration in μg /m^3 is given by

$$C_{A,vap} = M \times F_{comp} \times \frac{VP}{P_a} \times D \times \frac{1}{V_{evap}} \times 1E6 \quad (a3)$$

The P_a term is atmospheric pressure, D is duration of product use in minutes, and V_{evap} is the volume into which the evaporation occurs, which is assumed to be room volume of 5 m^3 in SHEDS. The calculated $C_{A,vap}$ value is compared to the saturation air concentration which may not be exceeded, no matter how much chemical is present. The daily inhalation exposure $E_{D,vap}$, (μg) is:

$$E_{D,vap} = U_1 \times U_2 \times prob\left(\frac{FR}{365}\right) \times C_{A,vap} \times \frac{D}{1440} \times BVA \times PAI \quad (a4)$$

D is the duration of the direct use in minutes; dividing by 1440 gives fraction of the day. The parameter BVA is the basal alveolar ventilation rate in cubic meters of air per day, which is a function of the simulated individual's sampled age, gender, and body weight. The physical activity index (PAI) is the duration-weighted average breathing rate expressed as a unitless multiple of the basal rate. The PAI for each person is supplied on the activity diary assigned to the individual, and was determined from the metabolic equivalent (METS) values associated with each CHAD activity. PAI and BVA are determined for each person from the CHAD diary using methods that have been previously described (Glen et al., 2012).

The other direct inhalation scenario is the inhalation of aerosols or sprays. This is generally similar to vapor inhalation, except that the airborne concentration depends on the formation and release of droplets, rather than on vapor pressure. Air concentration (μg /m^3) in this case is given by:

$$C_{A,aer} = \frac{M \times F_{comp} \times F_{airb}}{V_{Cloud}} \times 1E6 \quad (a5)$$

The default values for cloud volume V_{cloud} and airborne fraction F_{airb} are equivalent to those used in ConsExpo exposure model (Delmaar et al. 2005), and are given in Table S2. The corresponding inhalation exposure $E_{D,aer}$ is then given by an equation analogous to eq. a4.

Indirect Exposure Equations

Exposure to an indirect source results when a person encounters the specified chemical in the residence after its direct use, or "post-application". Exposure occurs as individuals contact different *media* within each micro. These media can be user-defined but are typically air, surfaces (including floors), and pets. Indirect exposures to chemicals may occur in any micro in SHEDS-HT, if the model is provided with distributions of chemical concentrations in the micro media (which can be defined in a flexible manner on the model input files). The residential micro is the only micro for which media concentrations can be modeled based on consumer product use or emission rates using the fugacity module. Currently, concentration distributions for any other micro-media pair must be provided directly. In the case study, exposure only occurs in the residential micro, and only surfaces and air media are used; any products used on pets are assumed to be applied to surfaces as no distinction was made in these runs between transfer rates or contact probabilities for pets versus surfaces. Therefore the exposure equations below (e.g., a6 and a7) are only calculated for the residential micros in the case study. SHEDS-HT contact probabilities for each media-micro pair used in the case study are given in Table S3. Exposure is proportional to both the contact time and the concentration (calculated from the fugacity module), and also depends on behavioral factors such as a transfer coefficient or chemical factors (such as the availability for potential transfer). The indirect pathway exposures in SHEDS-HT are daily totals over all the micros, and are expressed as four specific routes: dermal, inhalation, hand-to-mouth (non-dietary) ingestion, and object-to-mouth (non-dietary) ingestion.

The concentrations in the equations below for residential air and surfaces are determined from the fugacity module (Section B). For each indirect scenario, a mass of chemical used and a frequency of use (FR) are sampled from the consumer product use patterns (Table S8) for the consumer product being modeled. A parameter equal to the number of days since last use (t_{use}) is randomly sampled from a uniform distribution [1, N_{days}] where N_{days} is the number of days between uses of the chemical (N_{days}= 365/FR). The fugacity model is then run (using the equations and parameters described in Section B) for time t=$t_{use.}$ The individual being modeled is assigned the resulting air and surface concentrations ($C_{A,I}$ and $C_{S,I}$ below).

Inhalation exposure via the indirect pathway (µg) is given by

$$E_{I,inhal} = \frac{C_{A,I} \times D}{1440} \times BVA \times PAI \qquad (a6)$$

where $C_{A,I}$ is the average daily air concentration in the micro (e.g., residence) due to indirect sources (µg /m^3), D is the duration of time spent in the residence (min) and is determined from the assigned activity diary. BVA x PAI is the daily volume of inhaled air (m^3) as described above.

The indirect dermal route refers to chemical getting on the skin by touching contaminated surfaces. The dermal exposure in SHEDS-HT is the amount of chemical transferred onto the skin (per day), regardless of what happens to that chemical later. The dermal dose is the amount of chemical that enters the body by being absorbed through the skin. Typically, only a few percent of the dermal exposure becomes dermal dose. The remainder can be washed off, ingested (by hand-to-mouth contact), or removed without washing by dermal brush-off. The dermal dose and hand-to-mouth exposure both depend on the dermal exposure and on the size of the competing removal terms. Dermal exposure via the indirect route (µg/day) due to contact with surface media is given by:

$$E_{I,derm} = C_{S,I} \times D_c \times F_{avail} \times \frac{TC_{derm}}{60} \quad (a7)$$

$C_{S,I}$ is the average daily air surface concentration for the media within the micro (residential surfaces in the case study). The available fraction F_{avail} gives the fraction of the chemical present on surfaces that can be removed by touching. The transfer coefficient TC_{derm} quantifies the rate of transfer of chemical from surfaces to skin (cm^2/hr). The parameter D_c is the contact duration with surfaces (min/day), and 60 is a min/hr conversion factor. D_c is calculated as the product of the contact probability for the media (an input, see Table S3) and the time spent in the micro by that person (from the activity diary).

Exposure via the object-to-mouth route is given by

$$E_{OM} = E_{I,derm} \times F_{OM} \quad (a8)$$

This equation allows the object-to-mouth exposure pathway to be parameterized in terms of the indirect dermal exposure plus one route-specific fraction (F_{OM}). An appropriate distribution of F_{OM} (see Table S2) was determined from SHEDS-MM, which uses a more complex equation on a more finely resolved time-step to model the object-to-mouth pathway.

The ingestion hand-to-mouth exposure E_{HM} is considered a chemical removal process in SHEDS-HT and is described in the section "Dermal Removal Processes" below.

Dietary Exposure Methods

Dietary exposures in SHEDS-HT are calculated by determining the total mass of a chemical present in the food and water eaten by a simulated person within a day. SHEDS-MM considers on the order of 450 different food commodities that may contain chemical, and requires a distribution of chemical residues for each. SHEDS-HT has simplified this approach by considering larger food groups, by default a set of 41 crop groups and drinking water (although these can be user-defined and thus other groups can be used if provided in the same format). The list of default crop groups is given in Table S7. These default groups allow the user to input fewer chemical residue distributions while still maintaining variability in residues across food types due to differences in agricultural treatments or packaging.

Default food intake information in SHEDS-HT is also provided on a crop-group level. The SHEDS-HT intake diaries were developed from the National Health and Nutrition Examination Survey - What We Eat in America (NHANES-WWEIA) two-day food diaries. Each NHANES food diary was processed to calculate the mass of each default crop group consumed. The diaries are stored in SHEDS-HT by age and gender, and are sampled for each simulated individual in a manner analogous to the CHAD activity diaries. When distributions of chemical residues in each crop group (CG) are also supplied as input, daily dietary exposures can be calculated as

$$E_{dietary} = M_w \times C_w + \sum_{CG=1}^{N} M_{cg} \times C_{cg} \quad (a9)$$

Where N is the number of crop groups containing the chemical; drinking water and crop group residue concentrations (C_w and C_{cg}, µg/g) are sampled once per person and the consumed mass of water and crop group (M_w and M_{cg}, g) are obtained from the sampled food diary for the individual. Note that a chemical may be present in any number of food groups or in water; chemicals or food groups for which no concentration data are provided simply have 0 dietary exposure.

Aggregation of Chemical Exposures Across Scenarios and Routes

The SHEDS-HT model is linear; total exposure for each route associated with a chemical (inhalation, dermal, and ingestion) are summed over the available near-field scenarios (for example, a chemical may be found in dozens of consumer products having inhalation scenarios and each of these contributes to the inhalation exposure to the chemical if it is used on the simulated day). These sums can be quantified for each scenario-route as below where TE indicates daily total exposure (μg) and J is the number of active scenarios:

Direct dermal exposure:

$$\mathrm{TE}_{\mathrm{D,derm}} = \sum_1^{\mathrm{J}} \mathrm{E}_{\mathrm{D,derm}} \quad \text{(a10)}$$

Direct inhalation of aerosol:

$$\mathrm{TE}_{\mathrm{D,aer}} = \sum_1^{\mathrm{J}} \mathrm{E}_{\mathrm{D,aer}} \quad \text{(a11)}$$

Direct ingestion:

$$\mathrm{TE}_{\mathrm{D,ing}} = \sum_1^{\mathrm{J}} \mathrm{E}_{\mathrm{D,ing}} \quad \text{(a12)}$$

Direct inhalation of vapor:

$$\mathrm{TE}_{\mathrm{D,vap}} = \sum_1^{\mathrm{J}} \mathrm{E}_{\mathrm{D,vap}} \quad \text{(a13)}$$

Indirect inhalation:

$$\mathrm{TE}_{\mathrm{I,inhal}} = \sum_1^{\mathrm{J}} \mathrm{E}_{\mathrm{I,inhal}} \quad \text{(a14)}$$

Indirect dermal exposure:

$$\mathrm{TE}_{\mathrm{I,derm}} = \sum_1^{\mathrm{J}} \mathrm{E}_{\mathrm{I,derm}} \quad \text{(a15)}$$

Indirect ingestion via object to mouth:

$$\mathrm{TE}_{\mathrm{OM}} = \sum_1^{\mathrm{J}} \mathrm{E}_{\mathrm{OM}} \quad \text{(a16)}$$

These daily totals are then also summed across each route (dermal, ingestion, and inhalation). Total inhalation exposure for a chemical is the sum of the exposures due to total daily direct inhalation of aerosol, direct inhalation of vapor, and inhalation of chemical from indirect sources:

$$\mathrm{E}_{\mathrm{T,inhal}} = \mathrm{TE}_{\mathrm{D,aer}} + \mathrm{TE}_{\mathrm{D,vap}} + \mathrm{TE}_{\mathrm{I,inhal}} \quad \text{(a17)}$$

A partial daily ingestion exposure is the sum of exposures due to incidental ingestion during direct use, dietary intake, and object-to-mouth ingestion. Note that this total does not yet include hand-to-mouth ingestion (which is discussed, along with final ingestion exposure, in the following section).

$$E_{partial,ing} = TE_{D,ing} + E_{dietary} + TE_{OM} \quad (a18)$$

Total dermal exposure is given by the sum of the dermal exposures due to direct and indirect sources:

$$E_{T,derm} = TE_{D,derm} + TE_{I,derm} \quad (a19)$$

This dermal exposure can be thought of as the total mass of new chemical that ends up on the skin over the simulated day. This chemical can subsequently be removed by the processes described below (including hand-to-mouth exposure).

Dermal Removal Processes and Total Ingestion Intake

There are five competing processes for removing chemical from the surface of the skin: 1) dermal absorption, 2) hand-to-mouth transfer, 3) bathing, 4) hand washing, and 5) brush-off. One of the distinctive features of all the SHEDS models is that more frequent hand washing and/or bathing will lower both the dermal dose and the hand-to-mouth exposure. Even though SHEDS-HT is a simpler model than the other SHEDS models, it was considered necessary to maintain these features. Chemical removal by each of these five processes is modeled as a fraction of the dermal exposure from all direct and indirect scenarios:

$$R = E_{T,derm} \times F \quad (a20)$$

Where F can be equal to F_{HM} (hand-to-mouth transfer), $F_{A,derm}$ (dermal absorption), F_{HW} (hand washing), F_{BA} (bathing), or F_{BO} (brush-off). As noted earlier, the SHEDS-HT exposure module models one day per person, in a single time step. SHEDS-MM included the potential of carryover of dermal loading of chemical from one event to the next, and from one day to the next. As part of the SHEDS-HT simplification, it is implicitly assumed that the modeled day in SHEDS-HT ends with the same carryover as it began. The total chemical removed from the skin equals the new exposure on the modeled day, thus,

$$F_{HM} + F_{A,derm} + F_{HW} + F_{BA} + F_{BO} = 1 \quad (a21)$$

The means of the five F distributions sum to one. However, because the F values are randomly sampled, the five random samples will (almost) never sum to exactly one. Hence, the sampled values are interpreted as relative contributions to the removal. Each sample value is divided by the sum of the five, to force the standardized fractions to sum to unity. Each of the five removal processes is assigned an amount equal to its standardized fraction of the dermal exposure. F_{BA} and F_{BO} are inputs to the model; F_{BO} is > 0 on every simulated person-day, and F_{BA} is > 0 if a bath occurs on the simulated person-day (as sampled for each individual according to the probability of bathing $Prob_{BA}$, an input with a default value of 0.8). A bath/shower (on days when it occurs) will remove 70% of that day's dermal exposure, on average. In reality, the amount removed would depend on whether the exposure occurs primarily before or after the bath or shower. However, SHEDS-HT considers a whole day to be a single modeling time step, and there is no explicit sequence to the contact and removal processes. SHEDS-HT implicitly accounts for such effects in the variability distribution for the removal terms.

For the hand-to-mouth pathway, the exposure is the amount of chemical entering the gastrointestinal (GI) tract after removal from the hands. Thus,

$$E_{HM} = E_{T,derm} \times F_{HM} \quad \text{(a22)}$$

F_{HM} is a function of the hand-to-mouth frequency ($Freq_{HM}$) and the fraction of the hand area entering the mouth (A_{HM}), both of which are SHEDS-HT inputs (Table S2). The relationship between these input parameters and daily-level estimates of F_{HM} were estimated from runs of SHEDS-MM (which operates on a more detailed event-level time scale). The fitted relationship is:

$$F_{HM} = R_{HW} \times e^{-N_{HW}/11} \times A_{HM} \times \sqrt{Freq_{HM}} \quad \text{(a23)}$$

where R_{HW} is the fraction of chemical removed in a single handwash (an input) and N_{HW} is the sampled number of handwashes per day for the simulated person (based on the input parameter $Freq_{HW}$, the frequency of handwashing). The daily removal fraction due to handwashing (F_{HW}) was fit in a similar manner using SHEDS-MM results. The resulting relationship is

$$F_{HW} = R_{HW} \times \left(1 - e^{-N_{HW}/1.6}\right) \quad \text{(a24)}$$

Final intake ingestion can now be calculated now that hand-to-mouth intake has been estimated:

$$E_{T,ing} = E_{partial,ing} + E_{HM} \quad \text{(a25)}$$

The dermal dose is the amount of chemical absorbed into or through the skin. Thus,

$$D_{derm} = E_{T,derm} \times F_{A,derm} \quad \text{(a26)}$$

The default SHEDS-HT dermal absorption rate distribution (given in Table S2) was developed for SHEDS-MM for permethrin (Zartarian et al., 2012). However, the sampled rate here is linearly scaled as function of predicted permeability coefficient, K_p. Chemicals with similar K_p values should have similar absorption rates, while higher K_p produces more dermal absorption and lower K_p produces less. It is not clear whether the effect should be directly proportional to Kp, but that is the simplest assumption. Kp values were determined using the DERMWIN module of EPI Suite (USEPA 2012). $F_{A,derm}$ is thus given by:

$$F_{A,derm} = \frac{Kp}{Kp,permethrin} \times F_{A,derm0} \quad \text{(a27)}$$

where $F_{A,derm0}$ is the initial value sampled from the $F_{A,derm}$ distribution and $K_{p,permethrin}$ is the predicted value for permethrin (0.208 cm/hr).

Since a bath removes 70% on average, the other four removal processes total only 30% on bath days (on average), but they total 100% on non-bath days. Therefore, on average the absorbed dermal dose and the hand-to-mouth transfer are substantially higher on non-bath days. Similarly, the fraction removed by hand washing has a higher mean on days when the number of hand washings is higher. Again, the dermal dose and the hand-to-mouth transfer are substantially higher on days with little or no hand washing.

Absorption Rates: Intake Dose Estimates

SHEDS-HT uses simple fractions to track the fate of chemical once it has entered the body. Dermal absorption is one of the competing removal processes discussed above. For inhalation, the amount absorbed is given by:

$$D_{inhal} = E_{T,inhal} \times F_{A,inhal} \quad \text{(a28)}$$

Similarly, for ingestion the absorbed dose is given by:

$$D_{ing} = E_{T,ing} \times F_{A,ing} \quad \text{(a29)}$$

The total absorbed (intake) dose is the sum over the inhalation, ingestion, and dermal pathways:

$$D_{tot} = D_{inhal} + D_{ingest} + D_{derm} \quad \text{(a30)}$$

All of the variables above have units [µg/day]. The current approach of assigning a distribution of absorption rates will be retained while chemical-property-related (QSAR-based) and flux-based approaches are investigated for these pathways.

Table S1. SHEDS-HT input databases.

Database Description	Information Contained	Source(s)
Physiological Information	Body mass, height, and basal metabolic rate distributions or regressions by age/gender cohort	Developed for SHEDS-MM from NHANES (Glen et al. 2013)
Activity Diaries	Daily location (time spent in microenvironments) and activity (physical activity index PAI, a time-averaged metabolic equivalent) information for each age- and gender-specific CHAD diary	Calculated from EPA's CHAD (EPA 2014)
Food Diaries	Daily mass of food group (by default crop group; see Table S7) consumed by individuals	Calculated from NHANES-WWEIA food diaries (USDA 2014)
Population Data	Number of individuals in US in each age age/gender cohort	2000 US Census (U.S. Census Bureau 2000)
Chemical Properties	Chemical-specific property information, indexed by CAS number	Estimated using EPI Suite (EPA 2012)
Scenarios File	Scenario-specific and category-specific parameters as described in the main manuscript and Figure S1, indexed by consumer product category, food group, and CAS	Derived from consumer product use database and consumer product ingredient databases (Goldsmith et al. 2014, NLM 2014) as described in main manuscript

Table S2. Default SHEDS-HT exposure factor input parameters

Parameter	Description	Units	Dependencies	Value / Source in SHEDS-HT
F_{avail}	Fraction available for transfer from surfaces via touching	-		0.5 (assumed)
TC_{derm}	Dermal transfer coefficient	cm^2/hr		Lognormal (250,1.93) Fit to daily aggregated SHEDS-MM results (Glen et al. 2012)
$Freq_{HM}$	Hand-to-mouth frequency	hr^{-1}	Cohort	Age 1: Weibull (0.75,18) Age 2-5: Weibull (0.75,12.59) Age 6-10: Weibull (0.75,1.64) Age 11+: Weibull (0.75,.82) (Xue et al. 2007)
$Prob_{BA}$	Probability of bathing on a given day, if the CHAD diary did not record one	-		0.8 Same as SHEDS-MM (Glen et al. 2012)
F_{OM}	Object-to-mouth ratio (ratio of object-to-mouth exposure to indirect dermal exposure)	-	Cohort	Age 1: Triangle (0.0025,0.01,0.005) Age 2: Triangle (0.0015,0.006,0.003) Age 3-5: Triangle (0.001,0.004,0.002) Age 6-10: Triangle (0.0002,0.008,0.0004) Age 11+: 0 Fit using SHEDS-MM, which was parameterized based on Xue et al. (2010).
A_{HM}	Hand-to-mouth area fraction	-	Cohort	Age 1: Beta (5.5,25) Age 2: Beta (3.725) Age 3-5: Beta (3.7,25) Age 6-10: Beta (1.8,25) Age 11+: Triangle (0,0.02)

Parameter	Description	Units	Dependencies	Value / Source in SHEDS-HT
				Same as SHEDS-MM[1]
$Freq_{HW}$	Handwashing frequency	#/day		Lognormal (3.6,2) Same as SHEDS-MM (Glen et al. 2012)
F_{BA}	Daily chemical removal fraction (bathing)	-		Beta (4,1.36) Fit to daily aggregated SHEDS-MM results
R_{HW}	Chemical removal fraction from a single handwashing event	-		Triangle (0.05, 0.5, 0.25) Same as SHEDS-MM (Glen et al. 2012)
F_{BO}	Chemical removal fraction (brush-off)	-		Triangle (0.01, 0.25, 0.05) Daily fit to SHEDS-MM runs that assumed 1% per hour
$F_{A,derm}$	Absorption fraction (dermal)	-	Chemical	Initial distribution is Triangle (0.001, 0.01, 0.004). Sampled result is scaled by K_p (determined from EPI Suite) as described in eq. a27
$F_{A,inhal}$	Absorption fraction (inhalation)	-		0.16 Assumed
$F_{A,ing}$	Absorption fraction (ingestion)	-		Uniform (0.4, 0.8) Assumed
T_{micro}	Time spent in microenvironment	min	Microenvironment, person	Calculated from sampled cohort-appropriate CHAD activity diary for each simulated person
PAI	Physical activity index: mean metabolic equivalents (METS) in microenvironment	METS	Microenvironment, person	Calculated from sampled cohort-appropriate CHAD activity diary for each simulated person
F_{airb}	Fraction of product mass airborne for direct inhalation scenarios	-	Consumer product category	Uniform distributions (0.1-0.3 for trigger sprays; 0.90-1.0 for aerosols), with mean equal to ConsExpo values (Delmaar et al. 2005).
V_{cloud}	Volume of aerosol cloud for direct inhalation scenarios	m^3		Uniform distribution (0.0425 – 0.0825 m^3) having a mean equal to the ConsExpo default value (Delmaar et al. 2005).

Table S3. SHEDS-HT microenvironments, media, and assumed contact probabilities for the case study.

Microenvironment	Media	Case Study Contact Probability (fraction of time in micro spent in contact with environmental media)	Notes
Inside Home, Awake	Air	1	
Inside Home, Awake	Surfaces	1	Pets treated as surfaces in this case study (no difference in transfer coefficients)
Inside Home, Asleep	Air	1	
Inside Home, Asleep	Surfaces	0	No surface contact when sleeping

B. Fugacity Module

Reduction of an Indoor Fate and Transport Model

The simplified version of the fugacity-based indoor model incorporated in SHEDS-HT is based on an implementation of the model presented by Bennett and Furtaw (2004). The number of particle (dust) sizes in the model were reduced to two (nominal large and small particles); corresponding particle inputs were derived by averaging values for the 3 larger and 3 smaller sizes. The number of model compartments was also reduced to be consistent with the SHEDS-HT indoor media (namely air and surfaces). All horizontal surfaces in SHEDS-HT are assumed to have the same concentrations (and same contact and chemical transfer rates), and thus carpet and vinyl compartments were merged; the floor (surface) compartment in this reduced model is essentially a weighted average of the carpet and vinyl compartments in the original model. The walls were eliminated, as were an organic film on surfaces and embedded carpet particles. Subscripts for the final two model compartments are "a" (air) and "sf" (surfaces). Subscripts for large and small particles are given as "l" and "s."

The parameterization of the model was further reduced using a variance-decomposition based sensitivity analysis (Glen and Isaacs, 2012) to identify the model inputs most influencing concentrations in the air and on surfaces in treated and untreated surfaces given a constant chemical mass application. Sensitivity results (Sobol indices for total effect, essentially the percent variance in the model output resulting from variance in the input) for the air and surface compartments are given in Table S4 for parameters having indices greater than 0.01 (i.e. explaining >1% of the variance). Parameters that were retained as inputs to SHEDS-HT are discussed in the main manuscript and are given in Table S5.

For this screening-level application, ultimately the treated and untreated air and surface compartments were also merged, as SHEDS-HT doesn't currently explicitly differentiate between time spent in treated versus untreated areas; again, the concentrations (and resulting exposures due to contact) are then essentially an area-weighted average of the two. Full equations for the model as implemented in SHEDS-HT are given in the following sections.

Table S4. Fugacity model input parameters having Sobol sensitivity indices (total effect) greater than 0.01 in at least one model air or surface compartment.

The same 6 parameters have the highest sensitivity indices in each of the four compartments.

			Sobol Indices			
Parameter	**Description**	**Units**	**Untreated Room Air Concentration**	**Treated Room Air Concentration**	**Untreated Surfaces in Treated Room Concentration**	**Surfaces in Untreated Room Concentration**
VP	Vapor pressure	Pa	0.853	0.876	0.657	0.722
AER_o	Air exchange rate for rooms with outdoors	1/d	0.112	0.301	0.054	0.207
Sol	Solubility	mol/m^3	0.095	0.083	0.259	0.192
TH_{sf}	Effective thickness of surfaces	m	0.087	0.084	0.073	0.071
K_{ow}	Octanol-water partition coefficient	-	0.085	0.071	0.237	0.173
TH_b	Boundary layer thickness over surfaces	m	0.063	0.033	0.176	0.132
Ds_f	Chemical degradation rate constant on surfaces	1/d	0.054	0.039	0.056	0.046
AER_I	Air exchange rate between rooms	1/d	0.018	<0.01	0.019	<0.01
$L_{a,s}$	Loading of small particles in air	$\mu g/m^3$	<0.01	0.011	0.046	<0.01
$L_{a,l}$	Loading of large particles in air	$\mu g/m^3$	<0.01	0.011	0.031	<0.01
$R_{sf,l}$	Surfaces-to-air small particle resuspension rate	1/d	<0.01	<0.01	0.031	0.011
DC_a	Diffusion coefficient in air	m^2/d	<0.01	<0.01	0.025	0.017
$CL_{sf,s}$	Cleaning removal rate for small particles on surfaces	1/d	<0.01	<0.01	0.015	0.015
$R_{sf,s}$	Surfaces-to-air small particle resuspension rate	1/d	<0.01	<0.01	0.013	0.011
$L_{sf,l}$	Loading of large particles on surfaces	$\mu g/cm^2$	<0.01	<0.01	0.011	<0.01

Table S5. Final input variables for the reduced indoor fugacity module of SHEDS-HT and default values used in the case study.

Variable Name	Description	Units	Default Value in SHEDS-HT‡
AER_o	Air exchange rate for rooms with outdoors	1/d	Lognormal(11.9, 1.7); Assumed
MA_{sf}	Chemical mass applied to surfaces at t=0	g/m^2	Determined from category-specific consumer product use patterns (see Table S8).
MA_a	Chemical mass applied to air at t=0	$\mu g/m^3$	Assumed to be 0 for indirect pathways
H	Height of walls	m	Uniform(2.44,3); Assumed
A_f	Total floor area of the house	m^2	Lognormal(130, 1.8); Assumed
C_{out}	Chemical concentration in outdoor air	$\mu g/m^3$	Assumed to be 0 as default
$CI_{,a}$	Prior chemical concentration in air	$\mu g/m^3$	Assumed to be 0 as default
$CI_{,sf}$	Prior chemical concentration on surfaces	$\mu g/cm^2$	Assumed to be 0 as default
CS_a	chemical emission rate (source strength) in air	$\mu g/m^3/day$	User-supplied; not used in current case study
CS_{sf}	Chemical emission rate (source strength) in surfaces	$\mu g/m^2/day$	User-supplied; not used in current case study
D_a	Chemical degradation rate constant in air	1/d	Chemical-specific; estimated using EPI Suite
D_{sf}	Chemical degradation rate constant on surfaces	1/d	Chemical-specific; estimated using EPI Suite half-lives as described in main manuscript
DC_a	Diffusion coefficient in air	m^2/d	Chemical-specific; estimated using EPI Suite
K_{ow}	Octanol-water partition coefficient	-	Chemical-specific; estimated using EPI Suite
VP	Vapor pressure	Pa	Chemical-specific; estimated using EPI Suite
Sol	Solubility	mol/m^3	Chemical-specific; estimated using EPI Suite
MW	Molecular weight	g/mol	Chemical-specific; estimated using EPI Suite
CF_s	Organic carbon fraction for small particles	-	Normal (0.3,0.03); Mean estimated from values reported in Bennett and Furtaw (2004) for 3 smaller particle sizes, variability assumed
CF_l	Organic carbon fraction for large particles	-	Normal (0.15,0.01); Mean estimated from values reported in Bennett and Furtaw (2004) for 3 larger particle sizes, variability assumed
$CL_{a,s}$	Cleaning removal rate for small particles in air	1/d	Uniform (0.018,0.22); Mean estimated from values reported in Bennett and Furtaw (2004) for 3 smaller particle sizes, variability assumed
$CL_{a,l}$	Cleaning removal rate for large particles in air	1/d	Uniform (0.03, 0.5); Mean estimated from values reported in Bennett and Furtaw (2004) for 3 larger particle sizes, variability assumed
$CL_{sf,s}$	Cleaning removal rate for small particles on surfaces	1/d	Uniform (0.035, 0.045) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 smaller particle sizes, variability assumed
$CL_{sf,l}$	Cleaning removal rate for large particles on surfaces	1/d	Uniform (0.035, 0.045) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 larger particle sizes, variability assumed
$PD_{a,s}$	Air-to-floor small particle deposition rate	m/d	Normal (11,1) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 smaller particle sizes, variability assumed
$PD_{a,l}$	Air-to-floor large particle deposition rate	m/d	Normal (387,20) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 larger particle sizes, variability assumed

Variable Name	Description	Units	Default Value in SHEDS-HT‡
T	Indoor temperature	K	Normal (296,2) ; Assumed
TH_b	Boundary layer thickness over surfaces	m	Uniform (0.025,0.0275); Assumed
TH_{sf}	Effective thickness of surfaces	m	Normal (0.0098,0.002); Assumed
$R_{sf,s}$	Surface-to-air small particle resuspension rate	1/d	Uniform (0.00072, 0.00082) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 smaller particle sizes, variability assumed
$R_{sf,l}$	Surface-to-air large particle resuspension rate	1/d	Uniform (0.0015, 0.0017) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 larger particle sizes, variability assumed
$L_{a,s}$	Loading of small particles in air	$\mu g/m^3$	Uniform (15, 25) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 smaller particle sizes, variability assumed
$L_{a,l}$	Loading of large particles in air	$\mu g/m^3$	Uniform (2.2, 2.5) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 larger particle sizes, variability assumed
$L_{sf,s}$	Loading of small particles on surfaces	$\mu g/cm^2$	Uniform (6, 14.5) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 smaller particle sizes, variability assumed
$L_{sf,l}$	Loading of large particles on surfaces	$\mu g/cm^2$	Uniform (11.5, 28) Mean estimated from values reported in Bennett and Furtaw (2004) for 3 larger particle sizes, variability assumed

‡Normal distributions reported as (mean, SD); lognormal as (geometric mean, geometric standard deviation); uniform as (min, max)

Particle Masses and Cleaning Rates

Volume of air compartment (m^3):

$$V_a = A_f \times H \quad \text{(b1)}$$

Small and large particle masses in air (µg):

$$MP_{a,s} = V_a \times L_{a,s} \quad \text{(b2)}$$

$$MP_{a,l} = V_a \times L_{a,l} \quad \text{(b3)}$$

Small and large particle masses on surfaces (µg); 1E4 factor is for units conversion (cm^2 to m^2):

$$MP_{sf,s} = A_f \times 1E4 \times L_{sf,s} \quad \text{(b4)}$$

$$MP_{sf,l} = A_f \times 1E4 \times L_{sf,l} \quad \text{(b5)}$$

Cleaning rates from surfaces for large and small particles (1/day). These are sampled from the input distributions, but then constrained to force particle mass balance as below:

$$CL_{sf,s} \geq PD_{a,s} \times L_{a,s} / (1E4 \times L_{sf,s}) - R_{sf,s} \quad \text{(b6)}$$

$$CL_{sf,l} \geq PD_{a,l} \times L_{a,l} / (1E4 \times L_{sf,l}) - R_{sf,l} \quad \text{(b7)}$$

Cleaning rates from air for large and small particles (1/day). These are sampled from the input distributions, but then constrained to force particle mass balance as below:

$$CL_{,a,s} \geq (R_{sf,s} \times MP_{sf,s} - PD_{a,s} \times L_{a,s} \times A_f)/ MP_{a,s} \quad \text{(b8)}$$

$$CL_{,a,l} \geq (R_{sf,l} \times MP_{sf,l} - PD_{a,l} \times L_{a,l} \times A_f)/ MP_{a,l} \quad \text{(b9)}$$

Partition Coefficients

Conversion factor between µg and moles (µg/mol):

$$ugmol = 1E6 \times MW \quad \text{(b10)}$$

Air/surface partition coefficient (derived from the mean of the expressions for vinyl and carpet from Bennett and Furtaw, 2004):

$$K_{a,sf} = 82500 \times VP^{-0.65} \quad \text{(b11)}$$

Air/particle partition coefficent for small and large particles (m^3/µg), where the gas constant R_{gas}=8.314 Pa-m^3/(mol-K):

$$K_{p,s} = \frac{1.6625E-12 \times K_{ow} \times R_{gas} \times T \times CF_s}{VP} \quad \text{(b12)}$$

$$K_{p,l} = \frac{1.6625E-12 \times K_{ow} \times R_{gas} \times T \times CF_l}{VP} \quad \text{(b13)}$$

Fugacity Capacities and Fugacity to Mass Ratios

Fugacity capacity of air ([mol/(Pa m^3)]:

$$Z_{a,b} = \frac{1}{R_{gas} \times T} \quad \text{(b14)}$$

Fugacity capacity of bulk surface compartment ([mol/(Pa m^3)]:

$$Z_{sf,b} = K_{a,sf} \times Z_{a,b} \quad \text{(b15)}$$

Ratio of mass to fugacity (ZV, in µg/Pa) for bulk (vapor phase) air:

$$ZV_a = Z_{a,b} \times V_a \times \text{ugmol} \quad \text{(b16)}$$

Ratio of mass to fugacity (ZV, in µg/Pa) for surfaces:

$$ZV_{sf,b} = Z_{sf,b} \times A_f \times TH_{sf} \times \text{ugmol} \quad \text{(b17)}$$

Ratio of mass to fugacity (ZV, in µg/Pa) for small and large particles in the air compartment:

$$ZV_{a,s} = ZV_{a,b} \times K_{p,s} \times L_{a,s} \quad \text{(b18)}$$

$$ZV_{a,l} = ZV_{a,b} \times K_{p,l} \times L_{a,l} \quad \text{(b19)}$$

Unit capacities of large and small particles (fugacity capacity per unit mass, in 1/Pa):

$$CP_s = Z_a \times K_{p,s} \times \text{ugmol} = \frac{1.6625E{-}6 \times MW \times K_{ow} \times CF_s \times Sol}{VP} \quad \text{(b20)}$$

$$CP_l = Z_a \times K_{p,l} \times \text{ugmol} = \frac{1.6625E{-}6 \times MW \times K_{ow} \times CF_l \times Sol}{VP} \quad \text{(b21)}$$

Ratio of mass to fugacity (ZV, in µg/Pa) for small and large particles in the surface compartment:

$$ZV_{sf,s} = CP_s \times MP_{s,s} \quad \text{(b22)}$$

$$ZV_{sf,l} = CP_l \times MP_{s,l} \quad \text{(b23)}$$

Ratio of mass to fugacity (ZV, in µg/Pa) and fugacity to mass (iZV, Pa/ µg) for entire air compartment (sum of phase-specific ZV):

$$ZV_a = ZV_{a,b} + ZV_{a,s} + ZV_{a,l} \quad \text{(b24)}$$

$$iZV_a = (ZV_{a,b} + ZV_{a,s} + ZV_{a,l})^{-1} \quad \text{(b25)}$$

Ratio of mass to fugacity (ZV, in µg/Pa) and fugacity to mass (iZV, Pa/ µg) for entire surface compartment (sum of phase-specific ZV):

$$ZV_{sf} = ZV_{s,b} + ZV_{s,s} + ZV_{s,l} \quad \text{(b26)}$$

$$iZV_{sf} = (ZV_{sf,b} + ZV_{sf,s} + ZV_{sf,l})^{-1} \quad \text{(b27)}$$

Chemical Flows

Given the chemical mass in the air compartment M_a and the surface compartment M_{sf}, chemical flow via small and large particles (µg/day) from the air compartment due to any process X, either deposition (PD) or cleaning (CL):

$$Q_{X,a,s} = M_a \times MP_{a,s} \times iZV_a \times CP_s \times X_{a,s} \quad \text{(b28)}$$

$$Q_{X,a,l} = M_a \times MP_{a,l} \times iZV_a \times CP_l \times X_{a,l} \quad \text{(b29)}$$

Chemical flow (µg/day) to the air from the surface compartment is given by the following, where the process X is either resuspension (R) or cleaning (CL):

$$Q_{X,a,s} = M_{sf} \times MP_{sf,s} \times iZV_{sf} \times CP_s \times X_{sf,s} \quad \text{(b30)}$$

$$Q_{X,a,l} = M_{sf} \times MP_{sf,s} \times iZV_{sf} \times CP_l \times X_{sf,l} \quad \text{(b31)}$$

Chemical flow (µg/day) due to bulk air movement is given by the following equations. Flow from air to outdoors:

$$Q_{a\_o,b} = M_a \times AER_o \quad \text{(b32)}$$

Flow from outdoors to indoor air:

$$Q_{o\_a,b} = C_{out} \times AER_o \times V_a \quad \text{(b33)}$$

Transfer factors between air and surface (see Bennett and Furtaw, 2004) and diffusive flows from air to surfaces and surfaces to air:

$$Y_{a\_sf} = \min [DC_a \times Z_a / TH_b, 0.0135 \times (VP)^{-0.32}] \quad \text{(b34)}$$

$$Q_{a\_sf,df} = M_a \times A_f \times iZV_a \times ugmol \times Y_{a\_sf} \quad \text{(b35)}$$

$$Q_{sf\_a,df} = M_{sf} \times A_f \times iZV_{sf} \times ugmol \times Y_{a\_sf} \quad \text{(b36)}$$

Summary of Chemical Flows

All the chemical flows in the system that are proportional to the chemical mass in the "from" compartment are summarized here (source terms are handled below):

To	From	Mechanism	Chemical Flow Rate (per unit chemical mass in 'from' compartment)
surfaces	air	small particles-deposition	$A_f \times L_{a,s} \times iZV_a \times CP_s \times PD_{a,s}$
surfaces	air	large particles-deposition	$A_f \times L_{a,l} \times iZV_a \times CP_l \times PD_{a,l}$
surfaces	air	diffusion	$A_f \times iZV_a \times ugmol \times Y_{a\_sf}$
outdoors	air	bulk flow	AER_O
loss	air	small particles-cleaning	$MP_{a,s} \times iZV_a \times CP_s \times CL_{a,s}$
loss	air	large particles-cleaning	$MP_{a,l} \times iZV_a \times CP_l \times CL_{a,l}$
loss	air	degradation	D_a
air	surfaces	small particles-resuspension	$MP_{sf,s} \times iZV_{sf} \times CP_s \times R_{sf,s}$
air	surfaces	large particles-resuspension	$MP_{sf,l} \times iZV_{sf} \times CP_l \times R_{sf,l}$
air	surfaces	diffusion	$iZV_{sf} \times A_f \times ugmol \times Y_{a\_sf}$
loss	surfaces	small particles-cleaning	$MP_{sf,s} \times iZV_{sf} \times CP_s \times CL_{sf,s}$
loss	surfaces	large particles-cleaning	$MP_{sf,l} \times iZV_{sf} \times CP_l \times CL_{sf,l}$
loss	surfaces	degradation	D_{sf}

Construction of Jacobian Matrix

Define the following composite expressions to simplify the construction of the equations in the Jacobian matrix for solution of the system:

$$CL_a = iZV_a \times (MP_{a,s} \times CP_s \times CL_{a,s} + MP_{a,l} \times CP_l \times CL_{a,l}) \quad \text{(b37)}$$

$$CL_{sf} = iZV_{sf} \times (MP_{sf,s} \times CP_s \times CL_{sf,s} + MP_{sf,l} \times CP_l \times CL_{sf,l}) \quad \text{(b38)}$$

$$Dep = iZV_a \times A_f \times (L_{a,s} \times CP_s \times DP_{a,s} + L_{a,l} \times CP_l \times DP_{a,l}) \quad \text{(b39)}$$

$$Res = iZV_{sf} \times A_f \times (MP_{sf,s} \times CP_s \times R_{sf,s} + MP_{sf,l} \times CP_l \times R_{sf,l}) \quad \text{(b40)}$$

$$Diff_{sf} = iZV_{sf} \times ugmol \times A_f \times Y_{a\_sf} \quad \text{(b41)}$$

$$Diff_a = iZV_a \times ugmol \times A_f \times Y_{a\_sf} \quad \text{(b42)}$$

The Jacobian elements are then given by:

$$J_{11} = AER_o + D_a + CL_a + Dep + Diff_a \quad \text{(b43)}$$

$$J_{12} = -(Res + Diff_{sf}) \quad \text{(b44)}$$

$$J_{21} = -(Dep + Diff_a) \quad \text{(b45)}$$

$$J_{22} = D_{sf} + CL_{sf} + Res + Diff_{sf} \quad \text{(b46)}$$

In addition, there may be chemical source terms in each compartment (although these are assumed to be 0 in the case study). These are chemical inflows that are constant in time and do not depend on the amount of chemical in any compartment. There are only three such terms - two corresponding to the air

compartment and one to surfaces. The air compartment may have inflow from outdoor air, or an in-home source, or both. The floor compartment may have a single source term. All source terms have units of [μg/d]:

$$S_1 = C_{out} \times AER_o \times V_a + CS_a \times V_a \quad \text{(b47)}$$

$$S_2 = CS_a \times A_f \quad \text{(b48)}$$

Solution of the Model

The equation for the system of masses in each compartment is

$$\frac{d\mathbf{M}(t)}{dt} = -J\,\mathbf{M}(t) + \mathbf{S} \quad \text{(b49)}$$

Separating the chemical mass vector M(t) into a time-dependent part **MT**(t) and a constant part **MC** :

$$\mathbf{M}(t) = \mathbf{MT}(t) + \mathbf{MC} \quad \text{(b50)}$$

Then

$$\frac{d\mathbf{MT}(t)}{dt} = -J\,\mathbf{MT}(t) \quad \text{(b51)}$$

and

$$\mathbf{J\,MC} = \mathbf{S} \quad \text{(b52)}$$

The mass vectors **M**(t), **MT**(t), and **MC** , along with the source vector **S**, are 2x1 vectors with the first component representing the air compartment and the second representing the floor compartment. The Jacobian matrix J is 2x2. These equations are simple enough that the solutions may be given explicitly. Let the initial masses in the air and floor compartments be $m_{0,a}$ and $m_{0,sf}$, respectively, in units of μg. In summary, let

$$r = \sqrt{(J_{11})^2 + 4\,(J_{12}J_{21}) - 2\,(J_{11}J_{22}) + (J_{22})^2} \quad \text{(b53)}$$

$$mc_a = (J_{22} \times S_1 - J_{12} \times S_2) / (J_{11} \times J_{22} - J_{12} \times J_{21}) \quad \text{(b54)}$$

$$mc_f = (-J_{21} \times S_1 + J_{11} \times S_2) / (J_{11} \times J_{22} - J_{12} \times J_{21}) \quad \text{(b55)}$$

$$mt_{0,a} = m_{0,a} - mc_a \quad \text{(b56)}$$

$$mt_{0,f} = m_{0,f} - mc_f \quad \text{(b57)}$$

The eigenvalues and eigenvectors of the Jacobian matrix are

$$\lambda_1 = (J_{11} + J_{22} + r) / 2 \quad \text{(b58)}$$

$$\lambda_2 = (J_{11} + J_{22} - r) / 2 \quad \text{(b59)}$$

$$U_1 = \begin{pmatrix} U_{1a} \\ U_{1f} \end{pmatrix} = \begin{pmatrix} r + J_{11} - J_{22} \\ 2\,J_{21} \end{pmatrix} \quad \text{(b60)}$$

$$U_2 = \begin{pmatrix} U_{2a} \\ U_{2f} \end{pmatrix} = \begin{pmatrix} r - J_{11} + J_{22} \\ -2\,J_{21} \end{pmatrix} \quad \text{(b61)}$$

The determinant of the eigenvalue matrix is $\det U = U_{1a}U_{2f} - U_{1f}U_{2a} = -4\,rJ_{21}$.

In general, the initial state is a mix of the two eigenstates with amounts given by the constants k_{1a}, k_{2a}, k_{1f}, and k_{2f}. Each eigenstate decays exponentially at a rate that depends on its eigenvalue:

$$mt_a(t) = k_{1a}\,e^{-\lambda_1 t} + k_{2a}\,e^{-\lambda_2 t} \quad \text{(b62)}$$

$$mt_f(t) = k_{1f}\,e^{-\lambda_1 t} + k_{2f}\,e^{-\lambda_2 t} \quad \text{(b63)}$$

After some algebra, these constants are found to be

$$k_{1a} = \frac{U_{1a}U_{2f}}{\det U} mt_{0,a} - \frac{U_{1a}U_{2a}}{\det U} mt_{0,f} \quad \text{(b64)}$$

$$k_{2a} = -\frac{U_{1f}U_{2a}}{\det U} mt_{0,a} + \frac{U_{1a}U_{2a}}{\det U} mt_{0,f} \quad \text{(b65)}$$

$$k_{1f} = \frac{U_{1f}U_{2f}}{\det U} mt_{0,a} - \frac{U_{1f}U_{2a}}{\det U} mt_{0,f} \quad \text{(b66)}$$

$$k_{2f} = -\frac{U_{1f}U_{2f}}{\det U} mt_{0,a} + \frac{U_{1a}U_{2f}}{\det U} mt_{0,f} \quad \text{(b67)}$$

These equations determine the time-dependent mass **MT**(t). The total chemical mass in each compartment is then **MT**(t)+**MC**:

$$ma(t) = mc_a + k_{1a}\,e^{-\lambda_1 t} + k_{2a}\,e^{-\lambda_2 t} \quad \text{(b68)}$$

$$mf(t) = mc_f + k_{1f}\,e^{-\lambda_1 t} + k_{2f}\,e^{-\lambda_2 t} \quad \text{(b69)}$$

Once these masses are calculated for each time point, the corresponding air concentrations (μg/m^3) and surface concentrations (μg/m^2) are then calculated from the house volume and house floor area.

C. Summary of the Exposure Scenarios in the 2507 Chemical Case Study

Table S6. Scenarios in the SHEDS-HT case study and corresponding number of chemicals, consumer product categories, and consumer products.
Each chemical may be associated with multiple scenarios, categories, and/or products.

Scenario	Number of Chemicals	Number of Consumer Product Categories	Number of Products
Dietary	330	-	-
Direct Dermal	2203	229	18847
Direct Ingestion	303	6	566
Direct Inhalation of Aerosol	1099	62	6100
Direct Inhalation of Vapor	1979	164	13743
Indirect	945	77	6684
All Scenarios	2507	254	20187

D. SHEDS-HT Food Group Information

The food groups used in the SHEDS-HT case study are given in Table S7. Food intakes for each of these groups were derived from NHANES-What We Eat in America (USDA 2014; NHANES-WWEIA) food diaries, while concentrations for the groups were derived from Pesticide Data Program (USDA 2014; PDP) databases as described in the main manuscript. Note that the SHEDS-HT model is compatible with other food group definitions.

Table S7. SHEDS-HT default food groups (crop groups).

Crop Group Label in SHEDS	Crop Group Description
AS	Asparagus
BA	Banana
BF	Beef
BR	Brassica (Cole) Leafy Vegetables
BS	Berry and Small Fruit
BV	Bulb Vegetables
CF	Citrus Fruits
CG	Cereal Grains
CH	Chicken
CV	Cucurbit Vegetables
DP	Dairy Products
DW	Drinking Water (Direct, Indirect)
EF	Edible Fungi
EG	Egg
FI	Fish
FV	Fruiting Vegetables (except cucurbits)
GO	Goat
HM	Human milk
HO	Honey
HS	Herbs and Spices
LE	Leafy Vegetables (except Brassica vegetables)
LR	Leaves of Root and Tuber Vegetables
LV	Legume Vegetables (Succulent or dried)
MA	Mango
MG	Meat, game
NA	Nongrass Animal Feeds (Forage, Fodder, Straw and Hay)*
OS	Oilseeds
OT	Other
PA	Papaya
PE	Peanut
PF	Pome Fruits
PI	Pineapple
PO	Poultry, Other
PR	Pork
RA	Rabbit
RS	Raisins
RT	Root and Tuber Vegetables
SF	Stone Fruits
SH	Sheep
TN	Tree Nuts
TU	Turkey

*Alfalfa is only food commodity in this group

E. SHEDS-HT Consumer Product Category Information

Development of appropriate SHEDS-HT consumer product categories was based on modification and/or expansion of the original product categories in the Household Products Database (NLM 2014; HPBD). The Consumer Product Chemical Profile Database (Goldsmith et al. 2014; CPCPdb) categories were not considered as they were based on retail organization rather than product use. New categories were created from the HPDB categories when necessary to capture unique exposure-relevant characteristics of products within the original category. For example, multipurpose household adhesives were initially grouped with special-use hobby adhesives, but a new category was created to allow the assignment of higher prevalence of use to multipurpose glues. Other changes were made to capture differences in expected indoor versus outdoor use or differences in formulation that would impact exposure routes or algorithms (e.g. spray products). Finally, the HPDB categories were combined where appropriate, when it was unlikely that the use or scenarios for the products could be independently parameterized based on available data. This process resulted in a final set of 254 categories, given in Table S8. All products in the CPCdb and HPDB databases were then mapped to this harmonized set. The default SHEDS-HT use information for each category is also provided in the Table; variability in use parameters is added as described in the main manuscript. (Variables reported as percent values here are converted to fractional values for use the in the exposure equations in Section A.) These data were developed from available studies/sources where available (including default values used in existing models) or assumed using judgment (as described in the main manuscript). These 254 categories were then mapped to SHEDS-HT exposure scenarios (Table S9).

Table S8. SHEDS-HT consumer product categories and critical default usage information.

Category Number	Product Category	Frequency FR (year^{-1})	Mass per Use (g)	Prevalence, Males (%)	Prevalence, Females (%)	Prevalence, Children < 12 (%)	Duration of Direct Use (min)	Percent of Product in Contact with skin F_{cont} (%)*	Percent Retained on Skin after Direct Use F_{ret} (%)*	Percent of Product Ingested F_{ing} (%)*	Data Sources Considered (Not all variables may be present in sources; consensus values determined using judgement)	Notes
1	ARTS AND CRAFTS; ARTS AND CRAFTS ADHESIVE	22	30	40	40	40	22	50	1	0	ter Berg et al. (2007); Glue - Tube glue (hobby, small tube) ter Berg et al. (2007); Glue - Two-component glue ter Berg et al. (2007); vapor only: Glue - Hot melt adhesive Bennett et al. (2012); Hobby products	Prevalence estimated from Bennett et al. (2012)
2	ARTS AND CRAFTS; ARTS AND CRAFTS ADHESIVE, SPRAY	12	255	40	40	5	10	1	1	0	ter Berg et al. (2007); Glue - Spray glue	Prevalence for adults same as ARTS AND CRAFTS; ARTS AND CRAFTS ADHESIVE, otherwise assumed
3	ARTS AND CRAFTS; ARTS AND CRAFTS CLEANER	180	50	83	71	0	30	1	1	0		All assumed
4	ARTS AND CRAFTS; ARTS AND CRAFTS FINISH	12	50	1	2	2	30	0.1	1	0		All assumed
5	ARTS AND CRAFTS; ARTS AND CRAFTS FINISH, SPRAY	12	50	1	2	2	30	0.1	1	0		All assumed
6	ARTS AND CRAFTS; ARTS AND CRAFTS FRAGRANCES	12	5	1	1	1	10	1	1	0		All assumed
7	ARTS AND CRAFTS; ARTS AND CRAFTS PAINT	24	20	5	20	20	30	5	1	0		All assumed
8	ARTS AND CRAFTS; ARTS AND CRAFTS PAINT THINNER	12	20	1	1	1	10	1	1	0		All assumed
9	ARTS AND CRAFTS; ARTS AND CRAFTS PAINT, EXTERIOR	12	50	1	1	1	30	1	1	0		All assumed
10	ARTS AND CRAFTS; ARTS AND CRAFTS PAINT, SPRAY	12	20	2	2	2	30	1	1	0		All assumed
11	ARTS AND CRAFTS; ARTS AND CRAFTS SEALANT	12	20	2	2	2	10	1	1	0		All assumed
12	ARTS AND CRAFTS; BIKE TIRE SEALER	12	20	1	1	1	20	5	1	0		All assumed
13	ARTS AND CRAFTS; BODY PAINT	6	20	1	1	20	20	100	1	0	USEPA (2011); Leg and body paints Bremmer et al. (2006a); Face paint: Adults Bremmer et al. (2006a); Face paint: Children	Prevalence assumed
14	ARTS AND CRAFTS; CANDLE-MAKING	12	50	1	1	1	30	1	1	0		All assumed
15	ARTS AND CRAFTS; CERAMICS	12	350	1	1	10	60	10	1	0	Bremmer and van Veen (2002); modelling clay	Prevalence assumed
16	ARTS AND CRAFTS; DYE	12	50	1	1	1	30	1	1	0		All assumed
17	ARTS AND CRAFTS; FABRIC PAINTS AND SEALERS	12	50	1	5	5	30	1	1	0		All assumed
18	ARTS AND CRAFTS; FINGER PAINT	100	20	1	1	30	30	100	1	0	Bremmer and van Veen (2002); Finger paint	

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19	ARTS AND CRAFTS; FIXATIVE	12	20	5	5	1	10	1	1	0		All assumed
20	ARTS AND CRAFTS; FLOCKING	3	140	10	10	1	30	1	1	0	USEPA (2011); USEPA (1987); Glass frostings, window tints, and artificial snow	Ounces converted to grams using density of water
21	ARTS AND CRAFTS; FOGGER	1	100	1	1	1	60	1	1	0		All assumed
22	ARTS AND CRAFTS; GESSO	12	100	1	1	1	30	1	1	0		All assumed
23	ARTS AND CRAFTS; GLASS ETCHING/POLISHING	12	50	1	1	1	30	1	1	0		All assumed
24	ARTS AND CRAFTS; GLAZE	12	100	1	1	1	60	1	1	0		All assumed
25	ARTS AND CRAFTS; MODEL ENGINE FUEL	12	50	1	1	1	30	1	1	0		All assumed
26	ARTS AND CRAFTS; MODEL PAINT	12	50	5	5	10	60	1	1	0		All assumed
27	ARTS AND CRAFTS; OIL PAINT	12	50	10	10	20	60	1	1	0		All assumed
28	ARTS AND CRAFTS; PENS AND MARKERS	365	1	100	100	100	30	1	1	0		All assumed
29	ARTS AND CRAFTS; SOAP-MAKING	12	50	1	1	1	30	1	1	0		All assumed
30	AUTO PRODUCTS; ANTIFREEZE	7	500	3	3	0	20	0.05	1	0		All assumed
31	AUTO PRODUCTS; AUTO AIR FRESHENER	5	10	20	20	0	30	1	1	0		All assumed
32	AUTO PRODUCTS; AUTO DEGREASER	4	300	20	20	0	30	1	2	0	USEPA (2011); USEPA (1987); Engine degreasers USEPA (2011); USEPA (1987); Carburetor cleaners USEPA (2011); USEPA (1987); Transmission cleaners USEPA (2011); USEPA (1987); Brake quieters cleaners	Mass estimated based on 10 oz use Prevalence from USEPA (1987)
33	AUTO PRODUCTS; AUTO FLUIDS AND ADDITIVES	5	200	5	5	0	15	0.05	1	0	USEPA (2011); USEPA (1987); Battery terminal protectors USEPA (2011); USEPA (1987); Gasket remover USEPA (2011); USEPA (1987); Ignition and wire dryers	Higher masses assumed than reported based on other products not listed in source Prevalence from USEPA (1987)
34	AUTO PRODUCTS; AUTO LUBRICANT	11	50	18	18	0	20	0.05	1	0	USEPA (2011); USEPA (1987); Spray lubricant for cars	
35	AUTO PRODUCTS; AUTO PAINT	5	300	10	10	0	50	0.05	1	0	USEPA (2011); USEPA (1987); Aerosol spray paints for cars USEPA (2011); USEPA (1987); Auto spray primers	Prevalence from USEPA (1987)
36	AUTO PRODUCTS; AUTO REFRIGERANT	7	30	1	1	0	20	1	1	0		All assumed
37	AUTO PRODUCTS; BOAT CLEANER	2	500	1	1	0	120	5	1	0		All assumed
38	AUTO PRODUCTS; BOAT ENGINE FLUIDS	2	50	1	1	0	30	1	1	0		All assumed
39	AUTO PRODUCTS; BOAT PAINT	1	2000	1	1	1	120	1	1	0		All assumed
40	AUTO PRODUCTS; BODY REPAIR	3	100	1	1	0	20	1	1	0		All assumed
41	AUTO PRODUCTS; BODY WASH OR WAX	12	150	47	32	0	30	0.1	1	0	Moran et al. (2012); Car cleaner	
42	AUTO PRODUCTS; DETAILING	11	90	16	16	0	25	0.1	1	0	USEPA (2011); USEPA (1987); Tire/hubcap cleaners	Prevalence from USEPA (1987)
43	AUTO PRODUCTS; MOTOR OIL	7	500	50	50	0	20	1	1	0		All assumed
44	AUTO PRODUCTS; TIRE REPAIR	3	30	10	10	0	20	1	1	0		All assumed
45	AUTO PRODUCTS; WHEELS	7	100	3	3	0	20	0.05	1	0		All assumed

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46	AUTO PRODUCTS; WINDOWS/WINDSHIELD	5	100	5	5	0	30	1	1	0		All assumed
47	HOME MAINTENANCE; ADHESIVE	0.5	500	61	61	20	120	0.1	1	0	USEPA (2011); USEPA (1987); Adhesives ter Berg et al. (2007); Glue - Bottled glue - construction ter Berg et al. (2007); Glue - Wood parquet glue - parquet glued to surface ter Berg et al. (2007); Glue - Wood parquet glue - floating parquet ter Berg et al. (2007); Glue - Carpet glue ter Berg et al. (2007); Glue - Wallpaper glue ter Berg et al. (2007); Sealant - joints - assembly (glue)	Prevalence from USEPA (1987)
48	HOME MAINTENANCE; ADHESIVE REMOVER	1	500	24	24	0	90	0.1	1	0	USEPA (2011); USEPA (1987); Adhesive removers ter Berg et al. (2007); Removers - Glue remover ter Berg et al. (2007); Removers - Wall paper remover	
49	HOME MAINTENANCE; ADHESIVE, EXTERIOR	0.5	500	61	61	20	120	0.1	1	0		All assumed
50	HOME MAINTENANCE; BLEACHING OIL	12	200	1	1	0	30	1	1	0		All assumed
51	HOME MAINTENANCE; CAULK REMOVER	12	50	1	1	0	30	1	1	0		All assumed
52	HOME MAINTENANCE; CAULK/SEALANT	3	75	61	61	0	30	0.1	1	0	ter Berg et al. (2007); Sealant – cartridge	
53	HOME MAINTENANCE; CAULK/SEALANT, EXTERIOR	3	75	61	61	0	30	0.1	1	0	ter Berg et al. (2007); Sealant – cartridge	
54	HOME MAINTENANCE; CONCRETE	1	8000	5	5	0	120	0.01	1	0		All assumed
55	HOME MAINTENANCE; CONCRETE ADDITIVE	12	50	1	1	0	30	1	1	0		All assumed
56	HOME MAINTENANCE; CORROSION PROTECTION	6	90	8	8	0	20	0.1	1	0	USEPA (2011); USEPA (1987); Aerosol rust removers	Prevalence from USEPA (1987)
57	HOME MAINTENANCE; DEGREASER	15	100	28	28	1	30	0.1	1	0		All assumed
58	HOME MAINTENANCE; DRYWALL RETARDER	12	50	1	1	0	30	1	1	0		All assumed
59	HOME MAINTENANCE; ELECTRONICS LUBRICANT	12	20	1	1	0	30	1	1	0		All assumed
60	HOME MAINTENANCE; FINISH	2	1000	43	43	0	120	0.008	2	0	USEPA (2011); USEPA (1987); Wood stains, varnishes, and finishes ter Berg et al. (2007); Coating - Coating large surfaces ter Berg et al. (2007); Coating - Repair coatings	Prevalence from USEPA (1987)
61	HOME MAINTENANCE; FINISH GLAZE	12	50	1	1	0	30	1	1	0		All assumed
62	HOME MAINTENANCE; FINISH HARDENER	12	200	1	1	0	30	1	1	0		All assumed
63	HOME MAINTENANCE; FINISH, SPRAY	2	250	43	43	0	120	0.008	2	0		Prevalence same as HOME MAINTENANCE; FINISH

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64	HOME MAINTENANCE; FINISH, EXTERIOR	2	1000	43	43	0	120	0.008	2	0		Prevalence same as HOME MAINTENANCE; FINISH
65	HOME MAINTENANCE; GLAZING	12	200	1	1	0	30	1	1	0		All assumed
66	HOME MAINTENANCE; GROUT ADDITIVE	12	200	1	1	0	30	1	1	0		All assumed
67	HOME MAINTENANCE; GROUT HAZE REMOVER	12	200	1	1	0	30	1	1	0		All assumed
68	HOME MAINTENANCE; GROUT SEALER	1	200	5	5	0	30	1	1	0		All assumed
69	HOME MAINTENANCE; HOME MAINTENANCE CLEANER	24	100	20	20	0	2	0.1	1	0		All assumed
70	HOME MAINTENANCE; JOINT COMPOUND	4	500	10	10	0	30	3	1	0		All assumed
71	HOME MAINTENANCE; LACQUER	2	1000	43	43	0	120	0.008	2	0		Prevalence same as HOME MAINTENANCE; FINISH
72	HOME MAINTENANCE; LOCK DEICER	4	20	5	5	0	10	3	1	0		All assumed
73	HOME MAINTENANCE; LUBRICANT	10	30	40	40	0	9	1	1	0		All assumed
74	HOME MAINTENANCE; MORTAR OR GROUT	0.5	15000	10	10	0	360	0.008	1	0	ter Berg et al. (2007); Tile glue	Prevalence assumed
75	HOME MAINTENANCE; MULTIPURPOSE ADHESIVE	52	10	61	61	61	20	0.1	1	0	USEPA (2011); USEPA (1987); Adhesives ter Berg et al. (2007); Glue - Bottled glue - universal/wood	Prevalence from USEPA (1987)
76	HOME MAINTENANCE; PAINT	2	2000	40	40	5	120	0.008	1	0	ACI (2010); Paints Bremmer and van Engelen (2007); Brush / roller painting, solvent rich paint Bremmer and van Engelen (2007); Brush / roller painting, high solid paint Bremmer and van Engelen (2007); Brush / roller painting, waterborne paint Bremmer and van Engelen (2007); Brush / roller painting, waterborne wall paint USEPA (2011); USEPA((1987); Latex paint USEPA (2011); USEPA((1987); Oils-based paint	Prevalence estimated from USEPA (1987)
77	HOME MAINTENANCE; PAINT ADDITIVE	12	200	1	1	0	30	1	1	0		All assumed
78	HOME MAINTENANCE; PAINT CLEANER	12	50	5	5	0	10	10	1	0		All assumed
79	HOME MAINTENANCE; PAINT TEXTURE	4	200	1	1	0	30	1	1	0		All assumed
80	HOME MAINTENANCE; PAINT THINNER	3	500	36	36	0	40	0.008	1	0	USEPA (2011); USEPA (1987); Paint thinners	Prevalence from USEPA (1987)
81	HOME MAINTENANCE; PAINT, EXTERIOR	2	3000	40	40	5	120	0.008	1	0		Prevalence same as HOME MAINTENANCE; PAINT

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82	HOME MAINTENANCE; PAINT, INTERIOR	2	1000	40	40	5	120	0.008	1	0		Prevalence same as HOME MAINTENANCE; PAINT
83	HOME MAINTENANCE; PAINT, SPRAY	4	180	44	44	5	30	1	1	0	USEPA (2011); USEPA (1987); Aerosol spray paint Bremmer and van Engelen (2007); Spraying paint with a spray can Bremmer and van Engelen (2007); Pneumatic spraying of paint USEPA (2011): Spray Paint	Prevalence from USEPA (1987)
84	HOME MAINTENANCE; PATCH AND REPAIR	12	200	1	1	0	30	1	1	0		All assumed
85	HOME MAINTENANCE; PLASTER	0.5	200	10	10	0	60	0.008	1	0	ter Berg et al. (2007); Plasters and equalizers-Floor equalizer ter Berg et al. (2007); Plasters and equalizers-Wall plaster	Prevalence assumed
86	HOME MAINTENANCE; PLUMBING	12	50	1	1	0	60	1	1	0		All assumed
87	HOME MAINTENANCE; PORCELAIN	12	50	1	1	0	60	1	1	0		All assumed
88	HOME MAINTENANCE; PRESTAIN PRODUCTS	12	200	1	1	0	30	1	1	0		All assumed
89	HOME MAINTENANCE; PRIMER	3.5	550	14	14	0	90	0.1	1	0	USEPA (2011); USEPA (1987); Primers and special primers	Prevalence from USEPA (1987)
90	HOME MAINTENANCE; PRIMER, EXTERIOR	3.5	550	14	14	0	90	0.1	1	0		All assumed
91	HOME MAINTENANCE; PRIMER, INTERIOR	3.5	550	14	14	0	90	0.1	1	0		All assumed
92	HOME MAINTENANCE; PRIMER, SPRAY	3.5	250	14	14	0	90	0.1	1	0		All assumed
93	HOME MAINTENANCE; PUTTY OR FILLER	3	100	40	40	0	30	1	1	0	ter Berg et al. (2007); Fillers and putty-General filler from powder ter Berg et al. (2007); Fillers and putty-Large hole filler ter Berg et al. (2007); Fillers and putty-Filler/putty from tube ter Berg et al. (2007); Fillers and putty-Two-component filler ter Berg et al. (2007); Fillers and putty-Putty from spray	Prevalence assumed
94	HOME MAINTENANCE; REFRIGERANT	1	2	1	1	0	10	0	0	0		All assumed
95	HOME MAINTENANCE; ROOF	0.3	5000	1	1	0	480	0.1	1	0		All assumed
96	HOME MAINTENANCE; SEALANT	1	100	30	30	0	30	0.1	1	0		All assumed
97	HOME MAINTENANCE; SOLDER	12	20	10	5	0	15	0.1	1	0		All assumed
98	HOME MAINTENANCE; SPRAY FOAM	0.2	900	30	30	0	30	3	1	0	ter Berg et al. (2007); Insulation foam	Prevalence assumed
99	HOME MAINTENANCE; STAIN	2	1000	43	43	0	120	0.008	2	0		All assumed
100	HOME MAINTENANCE; STAIN, EXTERIOR	2	2000	43	43	0	120	0.008	2	0		All assumed
101	HOME MAINTENANCE; STAIN, SPRAY	2	250	43	43	0	120	0.008	2	0		All assumed
102	HOME MAINTENANCE; STRIPPER	2	500	30	30	0	120	0.008	1	0	USEPA (2011); USEPA (1987); Paint removers/strippers ter Berg et al. (2007); Removers - Paint remover ter Berg et al. (2007); Removers - Sealant / foam remover Prud'homme de Lodder et al. (2006a); Floor products- strippers	Prevalence from USEPA (1987)
103	HOME MAINTENANCE; STRIPPER, EXTERIOR	2	500	30	30	0	120	0.008	1	0		All assumed

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104	HOME MAINTENANCE; STUCCO REPAIR	1	500	1	1	0	60	0.1	1	0		All assumed
105	HOME MAINTENANCE; SUPER GLUE	12	0.5	61	61	5	5	0	0	0	ter Berg et al. (2007); Glue - Super glue	Prevalence same as HOME MAINTENANCE; MULTIPURPOSE ADHESIVE
106	HOME MAINTENANCE; SURFACE SEALER	1	100	40	40	0	30	5	1	0	USEPA (2011); USEPA (1987); Water repellents/protectors	Prevalence from USEPA (1987)
107	HOME MAINTENANCE; SURFACE SEALER, EXTERIOR	2	2250	9	9	0	60	0.01	1	0	USEPA (2011); USEPA (1987); Outdoor water repellents (for wood or cement)	Prevalence from USEPA (1987)
108	HOME MAINTENANCE; WELDING	4	20	1	1	0	60	0.1	1	0		All assumed
109	HOME MAINTENANCE; WOOD ADHESIVE	0.5	100	61	61	20	120	1	1	0	ter Berg et al. (2007); Glue - Bottled glue - universal/wood	Prevalence same as HOME MAINTENANCE; MULTIPURPOSE ADHESIVE
110	HOME MAINTENANCE; WOOD PRESERVATIVE	4	1000	20	20	0	120	0.1	1	0		All assumed
111	HOME OFFICE; PRINTER INK/TONER	104	1	40	40	40	20	0	0	0		All assumed
112	HOME OFFICE; WHITE OUT	12	3	2	2	0	8	0.1	1	0		All assumed
113	INSIDE THE HOME; AIR FRESHENER	365	5	52	52	0	30	0	0	0	Bremmer et al. (2006a); Essential oils -Air freshener Bennett et al. (2012); Air freshener Moran et al. (2012); Air freshener sprays Moran et al. (2012); Oils or air freshening candles SUPERB (Moran et al. 2012); Plug-ins SUPERB (Moran et al. 2012); Air Fresheners solids or gels SUPERB (Moran et al. 2012); Plain or scented candles	Prevalence estimated from Moran et al. (2012); Air Freshener Sprays
114	INSIDE THE HOME; ANTI-STATIC SPRAY	52	10	20	20	10	10	1	1	0		All assumed
115	INSIDE THE HOME; AUTOMATIC DISHWASHING ADDITIVE	365	20	40	40	5	5	1	0.1	0		All assumed
116	INSIDE THE HOME; AUTOMATIC DISHWASHING DETERGENT	365	50	70	70	0	5	1	1	0	Prud'homme de Lodder et al. (2006a); Machine dishwashing products - Powders Prud'homme de Lodder et al. (2006a); Machine dishwashing products - - Liquid USEPA (2011); Dish detergents USEPA (2011); Dishwashing liquid	Prevalence assumed

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117	INSIDE THE HOME; BATHROOM CLEANER	100	50	68	80	0	20	1	1	0	Prud'homme de Lodder et al. (2006a); Sanitary products - Bathroom cleaners- Sprays Prud'homme de Lodder et al. (2006a); Sanitary products - Bathroom cleaners- - Liquids Prud'homme de Lodder et al. (2006a); Sanitary products - Toilet cleaners Prud'homme de Lodder et al. (2006a); Sanitary products - Toilet rim cleaners Moran et al. (2012); Tub/shower cleaner Bennett et al. (2012); Bathroom products USEPA (2011); Bathroom tile cleaners USEPA (2011); Toilet cleaner	Prevalence estimated from Moran et al. (2012)
118	INSIDE THE HOME; BLEACH	104	50	80	80	.	30	5	1	0		All assumed
119	INSIDE THE HOME; CARPET CLEANER	12	200	52	52	0	30	0.1	1	0	Prud'homme de Lodder et al. (2006a); Carpet products - Liquids Prud'homme de Lodder et al. (2006a); Carpet products - Spray extraction machine Prud'homme de Lodder et al. (2006a;) Carpet products - Spray foams spot cleaner Moran et al. (2012); Carpet cleaner USEPA (2011); Rug Cleaners/Shampoos	Prevalence estimated from Moran et al. (2012)
120	INSIDE THE HOME; CARPET DEODORIZER	12	500	20	20	0	30	0.1	1	0	Prud'homme de Lodder et al. (2006a) Carpet products - Powders	
121	INSIDE THE HOME; CLEANER	180	50	71	83	0	30	1	1	0	USEPA (2011); USEPA (1987); Spot removers Prud'homme de Lodder et al. (2006a); Abrasives - Liquids Prud'homme de Lodder et al. (2006a); Abrasives - Powders ACI (2010); All-purpose cleaning liquid ACI (2010); APC gel (neat/non-dilutable) Moran et al (2012); All-purpose cleaner Bennett et al. (2012); All-purpose cleaning Bennett et al. (2012); Ammonia products USEPA (2011); Liquid cleansers USEPA (2011); Scouring powders USEPA (2011); All-purpose cleaners	Prevalence estimated from Moran et al. (2012)
122	INSIDE THE HOME; DISH SOAP	462	100	90	90	30	30	5	1	0	Prud'homme de Lodder et al. (2006a); Dishwashing products - Hand dishwashing liquids ACI (2010); Dishwashing liquids – hand-wash (dishware deposition)	Prevalence assumed
123	INSIDE THE HOME; DISINFECTANT	365	50	57	57	20	10	0.1	1	0	Prud'homme de Lodder et al. (2006b); Disinfectants for use indoors	Prevalence same as INSIDE THE HOME; DISINFECTANT, SPRAY
124	INSIDE THE HOME; DISINFECTANT, SPRAY	365	23	57	57	20	10	1	1	0	Bennett et al. (2012); Disinfectant spray	
125	INSIDE THE HOME; DRAIN	4	500	30	30	0	20	0.038	1	0	Prud'homme de Lodder et al. (2006a) Drain openers	Prevalence assumed

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126	INSIDE THE HOME; DRY CLEANER	12	3	5	5	5	30	0	0	0		All assumed
127	INSIDE THE HOME; ELECTRONICS CLEANER	13	5	13	13	0	10	0.1	1	0	USEPA (2011); USEPA (1987); Specialized electronic cleaners	Prevalence from USEPA (1987)
128	INSIDE THE HOME; FABRIC DEODORIZER	104	50	70	70	20	15	1	1	0		All assumed
129	INSIDE THE HOME; FABRIC PROTECTANT	12	20	40	40	5	10	1	1	0		All assumed
130	INSIDE THE HOME; FABRIC SOFTENER	104	100	80	80	5	5	1	1	0	Prud'homme de Lodder et al. (2006a); Laundry products - Fabric conditioners	Prevalence assumed
131	INSIDE THE HOME; FIREPLACE	2	50	1	1	0	30	1	1	0		All assumed
132	INSIDE THE HOME; FLOOR CLEANER	100	600	63	69	0	30	0.1	1	0	Prud'homme de Lodder et al. (2006a); Floor and furniture products: Floor cleaning liquid Prud'homme de Lodder et al. (2006a); Floor products- Wet tissues SUPERB (Moran et al 2012); Floor cleaner USEPA (2011); Floor cleaners	Prevalence from Moran et al. (2012)
133	INSIDE THE HOME; FLOOR POLISH	2	550	63	69	0	30	1	1	0	Prud'homme de Lodder et al. (2006a); Floor products- Polishes	Prevalence same as INSIDE THE HOME; FLOOR CLEANER
134	INSIDE THE HOME; FLOOR SEALER	2	550	63	69	0	30	1	1	0	Prud'homme de Lodder et al. (2006a); Floor products- Sealers	Prevalence same as INSIDE THE HOME; FLOOR CLEANER
135	INSIDE THE HOME; FURNITURE WAX	12	50	50	50	5	30	1	1	0		All assumed
136	INSIDE THE HOME; GARBAGE DISPOSAL DEODORIZER	12	50	3	3	0	5	1	1	0		All assumed
137	INSIDE THE HOME; GLASS CLEANER	72	20	86	88	0	30	5	1	0	Prud'homme de Lodder et al. (2006a) Glass cleaners Moran et al. (2012); Glass cleaner Bennett et al. (2012); Glass cleaner USEPA (2011); Glass Cleaners	Prevalence from Moran et al. (2012)
138	INSIDE THE HOME; GROUT CLEANER	52	50	40	40	0	30	5	1	0		All assumed
139	INSIDE THE HOME; GUM REMOVER	4	30	5	5	0	10	20	1	0		All assumed
140	INSIDE THE HOME; HAND CLEANER	52	20	30	30	30	2	100	1	0		All assumed
141	INSIDE THE HOME; HOUSEPLANT CARE	52	20	1	1	0	10	1	1	0		All assumed
142	INSIDE THE HOME; LAMP OIL/LIGHTER FLUID	12	10	10	10	0	5	1	1	0		All assumed
143	INSIDE THE HOME; LAUNDRY DETERGENT	365	200	80	100	20	10	1	1	0	Prud'homme de Lodder et al. (2006a); Laundry products - Powders Prud'homme de Lodder et al. (2006a); Laundry products - Liquids ACI (2010); Laundry detergent – powder USEPA (2011); Laundry Detergents	Prevalence assumed

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144	INSIDE THE HOME; LAUNDRY STAIN REMOVER	128	5	80	80	5	10	2	1	0	Prud'homme de Lodder et al. (2006a); Laundry pre-treatment products - Sprays Prud'homme de Lodder et al. (2006a); Laundry pre-treatment products - Liquids Prud'homme de Lodder et al. (2006a); Laundry pre-treatment products – Pastes	Prevalence assumed
145	INSIDE THE HOME; LAUNDRY STARCH	52	4.5	40	40	2	10	0.1	1	0		All assumed
146	INSIDE THE HOME; LEATHER CLEANER	12	135	50	50	0	10	0.2	1	0	Prud'homme de Lodder et al. (2006a); Furniture and leather products - Leather furniture spray	
147	INSIDE THE HOME; LIME REMOVER	24	50	30	30	0	30	2	1	0		All assumed
148	INSIDE THE HOME; METAL POLISH	12	50	50	50	0	10	0.1	1	0	Bennett et al. (2012); Metal polish	
149	INSIDE THE HOME; OVEN CLEANER	26	30	38	38	0	20	0.8	1	0	Prud'homme de Lodder et al. (2006a); Oven cleaners Moran et al. (2012); Oven cleaner Bennett et al. (2012); Oven cleaner	Prevalence estimated from Moran et al. (2012)
150	INSIDE THE HOME; PRODUCE CLEANER	52	20	10	10	1	5	1	1	1		All assumed
151	INSIDE THE HOME; SHOE POLISH OR PROTECTANT	11	40	12	12	1	5	0.3	1	0	USEPA (2011); USEPA (1987); Spray shoe polish Prud'homme de Lodder et al. (2006a); Shoe polish products - Spray Prud'homme de Lodder et al. (2006a); Shoe polish products - Cream	
152	INSIDE THE HOME; SILVER CLEANER	4	30	10	10	1	20	1	1	0		All assumed
153	INSIDE THE HOME; STARCH	52	30	30	30	0	30	1	1	0		All assumed
154	INSIDE THE HOME; SURFACE CLEANER	365	20	100	100	20	30	4	1	0	Prud'homme de Lodder et al. (2006a); All-purpose cleaners - Liquids Prud'homme de Lodder et al. (2006a); All-purpose cleaners - Sprays Prud'homme de Lodder et al. (2006a); All-purpose cleaners - Wet tissues Prud'homme de Lodder et al. (2006a); Metal cleaners ACI (2010); Hard surface cleaner-powder ACI (2010); APC spray (neat/non-dilutable) ACI (2010); Triggers spray cleaners USEPA (2011); All-purpose cleaner	
155	INSIDE THE HOME; UPHOLSTERY CLEANER	12	50	40	40	1	30	1	1	0		All assumed
156	INSIDE THE HOME; WASHING MACHINE CLEANER	12	100	1	1	0	10	1	1	0		All assumed
157	INSIDE THE HOME; WAX REMOVER	2	2000	5	5	0	60	0.01	1	0		All assumed

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158	INSIDE THE HOME; WOOD POLISH	30	300	54	64	0	60	5	1	0	USEPA (2011); USEPA (1987); Wood floor and paneling cleaners Prud'homme de Lodder et al. (2006a); Furniture and leather products - Furniture polish SUPERB (Moran et al 2012); Polish USEPA (2011); Furniture Polish	Prevalence estimated from Moran et al. (2012)
159	LANDSCAPE/YARD; BUBBLE SOLUTION	24	20	5	5	60	30	20	1	0		All assumed
160	LANDSCAPE/YARD; CLEANER, EXTERIOR	4	1000	60	40	0	120	0.01	1	0	Prud'homme de Lodder et al. (2006a); Pressure washers	Prevalence assumed
161	LANDSCAPE/YARD; COMPOST	1	40000	3	3	1	60	0	1	0		All assumed
162	LANDSCAPE/YARD; COMPOST TREATMENTS	4	50	1	1	0	10	1	1	0		All assumed
163	LANDSCAPE/YARD; FERTILIZER	2	20000	30	30	1	60	0.001	1	0		All assumed
164	LANDSCAPE/YARD; GARDEN CARE, OTHER	12	100	20	20	1	30	1	1	0		All assumed
165	LANDSCAPE/YARD; GARDEN FERTILIZER	4	10000	40	40	1	120	0.001	1	0		All assumed
166	LANDSCAPE/YARD; GRILL/CAMPING FUEL	12	20	50	30	0	30	0	0	0		All assumed
167	LANDSCAPE/YARD; HERBICIDE	2	10000	30	30	0	2	0.01	1	0		All assumed
168	LANDSCAPE/YARD; HOT TUB/SPA CHEMICALS	52	50	3	3	0	10	1	1	0		All assumed
169	LANDSCAPE/YARD; HUMUS	2	10000	5	5	1	120	0.01	1	0		All assumed
170	LANDSCAPE/YARD; LAWN CARE, OTHER	12	1000	10	10	1	60	0.1	1	0		All assumed
171	LANDSCAPE/YARD; LAWN FERTILIZER	2	5000	30	30	.	2	1	1	0		All assumed
172	LANDSCAPE/YARD; LAWN FUNGICIDE	2	2500	5	5	0	2	0.1	1	0		All assumed
173	LANDSCAPE/YARD; LAWN SEED	4	20000	40	40	1	60	0.01	1	0		All assumed
174	LANDSCAPE/YARD; LAWNMOWER FLUIDS	12	100	5	1	0	10	1	1	0		All assumed
175	LANDSCAPE/YARD; MULCH	4	20000	60	60	5	120	0.01	1	0		All assumed
176	LANDSCAPE/YARD; POND TREATMENTS	4	50	2	2	0	10	0.1	1	0	Prud'homme de Lodder et al. (2006b); Algae, green deposit removers -spray	Prevalence assumed
177	LANDSCAPE/YARD; POOL CHEMICALS	28	500	5	5	0	10	1	1	0	Prud'homme de Lodder et al. (2006b); Swimming pool disinfectants -Control of bacteria, algae and other micro-organisms -liquid Prud'homme de Lodder et al. (2006b); Swimming pool disinfectants -Control of algae - granules or tablets	Prevalence assumed
178	LANDSCAPE/YARD; POTTING SOIL	12	250	20	20	5	60	1	1	0		All assumed

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179	LANDSCAPE/YARD; SKUNK ODOR REMOVER	1	100	1	1	1	30	1	1	0		All assumed
180	LANDSCAPE/YARD; SURFACE DEICER	3	1000	10	10	0	60	0.1	1	0		All assumed
181	LANDSCAPE/YARD; TOOL LUBRICANT	12	200	5	1	0	30	1	1	0		All assumed
182	LANDSCAPE/YARD; TOPSOIL	2	20000	30	30	5	120	0.01	1	0		All assumed
183	LANDSCAPE/YARD; TREES	4	100	1	1	0	20	1	1	0		All assumed
184	PERSONAL CARE; AFTERSHAVE	132	1.2	20	0	0	5	100	100	0	Bremmer et al. (2006a); Men's cosmetics - Aftershave ACI (2010); Aftershave Wu et al. (2010); Aftershave (Adult) Wu et al. (2010); Aftershave (Child) Bennett et al. (2012); Aftershave/men's fragrance	Prevalence estimated from Wu et al. (2010)
185	PERSONAL CARE; BABY CONDITIONER	156	20	0	0	40	10	70	1	0		All assumed
186	PERSONAL CARE; BABY LOTION	182.5	5	1	1	40	10	100	80	0	USEPA (2011); Baby Lotion - baby use USEPA (2011); Baby Lotion - Adult use USEPA (2011); Baby Oil - baby use USEPA (2011); Baby Oil - Adult use USEPA (2011); Baby Cream - baby use USEPA (2011); Baby Cream - Adult use Bremmer et al. (2006a); Baby care Baby salve Bremmer et al. (2006a); Baby care baby oil ACI (2010); Baby lotions and creams Wu et al. (2010); Baby oil (Child) Bennett et al. (2012); Baby lotion USEPA (2011); Sathyanarayana et al. (2008); Baby lotion	Prevalence assumed
187	PERSONAL CARE; BABY OIL	51.1	5	5	5	30	5	100	100	0		All assumed
188	PERSONAL CARE; BABY POWDER	730	0.8	5	5	14	10	100	30	0	USEPA (2011); Baby Powder - baby use USEPA (2011); Baby Powder - Adult use Bremmer et al. (2006a); Baby care baby powder USEPA (2011); Sathyanarayana et al. (2008); Baby powder	
189	PERSONAL CARE; BABY SHAMPOO	51.1	5	1	1	70	10	100	10	0	USEPA (2011); Baby Shampoo - baby usec USEPA (2011); Baby Shampoo - Adult use Bennett et al. (2012); Baby shampoo USEPA (2011); Sathyanarayana et al. (2008); Baby shampoo	Prevalence assumed
190	PERSONAL CARE; BABY WASH	365	5	1	1	73	10	100	30	0	ACI (2010); Baby/Bath liquid Bennett et al. (2012); Baby bath	
191	PERSONAL CARE; BABY WIPES	52	2	5	5	20	5	50	5	0	USEPA (2011); Sathyanarayana et al. (2008); Baby wipes	
192	PERSONAL CARE; BAR SOAP	1095	5	90	90	90	2	100	5	0	USEPA (2011); Bath soaps Bremmer et al. (2006a); Washing hands - soap ACI (2010); F&H bar soap -Hand ACI (2010); F&H bar soap -Body	

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193	PERSONAL CARE; BATH OIL/SALTS	50	25	30	30	30	20	100	10	0	USEPA (2011); Bath oils USEPA (2011); Bath tablets USEPA (2011); Bath salts USEPA (2011); Bath capsules Bremmer et al. (2006a); Bath oil Bremmer et al. (2006a); Bath salts Bremmer et al. (2006a); Essential oils -Bath	
194	PERSONAL CARE; BODY HAIR BLEACH	3.65	50	2	2	0	20	100	1	0		All assumed
195	PERSONAL CARE; BODY LOTION	365	30	30	70	70	20	100	10	0	USEPA (2011); Fragrance lotion USEPA (2011); Face, body and hand preps Bremmer et al. (2006a); Skin care cream - Body lotion ACI (2010); Body moisturizer Wu et al. (2010); Body lotion (Adult) Wu et al. (2010); Body lotion (Child) Bennett et al. (2012); Lotion hand and body USEPA (2011); Loretz et al. 2005: Body lotion, hands USEPA (2011); Loretz et al. 2005: Body lotion, arms USEPA (2011); Loretz et al. 2005: Body lotion, feet USEPA (2011); Loretz et al. 2005: Body lotion, legs USEPA (2011); Loretz et al. 2005: Body lotion	Prevalence estimated from Wu et al. (2010)
196	PERSONAL CARE; BODY MAKEUP	1	50	5	5	0	10	100	100	0		All assumed
197	PERSONAL CARE; BODY POWDER	65.7	2	20	50	20	5	50	50	0	USEPA (2011); Powders	Prevalence assumed
198	PERSONAL CARE; BODY WASH	365	12	80	80	80	10	100	5	0	Bremmer et al. (2006a); Showering - soap Bremmer et al. (2006a); Showering - gel Bremmer et al. (2006a); Skin care - Body pack ACI (2010); Liquid Soap-body ACI (2010); Body wash Wu et al. (2010); Bath gel (Adult) Wu et al. (2010); Bath gel (Child) Bennett et al. (2012); Body wash USEPA (2011); Loretz et al. 2006: Body wash	Prevalence estimated from Wu et al. (2010)
199	PERSONAL CARE; BODY WIPES	1095	2	50	50	94	20	100	50	0		All assumed
200	PERSONAL CARE; BUBBLE BATH	2.92	20	6	15	43	20	20	5	0	USEPA (2011); Bubble baths USEPA (2011); Bath crystals Bremmer et al. (2006a); Bath foam ACI (2010); Bath Foam/Bubble bath Bennett et al. (2012); Bubble bath	
201	PERSONAL CARE; CLIPPER LUBRICANT	12	30	3	1	0	10	1	1	0		All assumed

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202	PERSONAL CARE; CONDITIONER	255.5	15	56	92	70	4	50	2	0	USEPA (2011); Hair conditioners USEPA (2011); Hair rinses Bremmer et al. (2006a); Hair care - conditioner ACI (2010); Hair rinses Wu et al. (2010); Hair conditioner (Adult) Wu et al. (2010); Hair conditioner (Child) USEPA (2011); Loretz 2008: Conditioner	Prevalence estimated from Wu et al. (2010)
203	PERSONAL CARE; CONTACT CARE	365	10	40	40	10	1	50	10	0	Wu et al. (2010); Contact lens solution (Adult)	Prevalence assumed
204	PERSONAL CARE; DENTURE PRODUCTS	365	20	10	10	0	5	50	100	2		All assumed
205	PERSONAL CARE; DEODORANT	365	2	100	100	10	5	100	100	0	USEPA (2011); Underarm deodorants Bremmer et al. (2006a); Deodorant stick / roller Bremmer et al. (2006a); Deodorant spray ACI (2010); Antiperspirants–roll-ons ACI (2010); Antiperspirant aerosols ACI (2010); Antiperspirant solid/bar Wu et al. (2010); Deodorant (Adult) Wu et al. (2010); Deodorant (Child) USEPA (2011); Loretz et al. 2006: Solid antiperspirant	Prevalence estimated from Wu et al. (2010)
206	PERSONAL CARE; DEPILATORY	17	5.5	10	20	0	15	100	0.05	0	USEPA (2011); Depilatories Bremmer et al. (2006a); Depilatories	Prevalence assumed
207	PERSONAL CARE; DIAPER CREAM	730	3	0	0	33	5	100	100	0	USEPA (2011); Sathyanarayana et al. (2008); Diaper cream	Prevalence assumed
208	PERSONAL CARE; EYE MAKEUP	365	1	1	79	2	5	100	100	0	USEPA (2011); Eyebrow pencil USEPA (2011); Eyeliner USEPA (2011); Eye shadow USEPA (2011); Mascara USEPA (2011); Under eye cover Bremmer et al. (2006a); Make-up - eye shadow Bremmer et al. (2006a); Make-up - mascara Bremmer et al. (2006a); Make-up - eyeliner Wu et al. (2010); Mascara (Adult) Wu et al. (2010); Makeup mascara (Child) USEPA (2011); Loretz 2008: Eye shadow	Prevalence estimated from Wu et al. (2010)
209	PERSONAL CARE; EYE PRODUCTS, OTHER	365	1	5	20	0	5	100	100	0	USEPA (2011); Eye lotion USEPA (2011); Eye makeup remover Bremmer et al. (2006a); Eye makeup remover	Prevalence assumed

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210	PERSONAL CARE; FACE CREAM	182.5	5	29	81	10	5	100	100	0	USEPA (2011); Moisturizers USEPA (2011); Night skin care products USEPA (2011); Skin lighteners USEPA (2011); Wrinkle smoothers (removers) USEPA (2011); Facial cream Bremmer et al. (2006a); Skin care cream - Face cream Bremmer et al. (2006a); Skin care - Skin whitening products ACI (2010); Other–Makeup remover Wu et al. (2010); Facial moisturizer (Adult) Wu et al. (2010); Anti-aging or overnight cream (Adult) Bennett et al. (2012); Facial moisturizer USEPA (2011); Loretz et al. 2005: Face cream	Prevalence estimated from Wu et al. (2010)
211	PERSONAL CARE; FACE MAKEUP	365	2	5	65	0	5	100	100	0	USEPA (2011); Blusher and rouge USEPA (2011); Face powders USEPA (2011); Foundations USEPA (2011); Makeup bases USEPA (2011); Makeup fixatives Bremmer et al. (2006a); Make-up - Facial make-up ACI (2010); Face/eye cosmetics foundation liquid Wu et al. (2010); Foundation (Adult) Bennett et al. (2012); Foundation USEPA (2011); Loretz et al. 2006: Liquid foundation	Prevalence estimated from Wu et al. (2010)
212	PERSONAL CARE; FACE WASH	547.5	10	23	73	10	5	100	5	0	USEPA (2011); Cleansing products (cold creams, cleansing lotions, liquids, and pads) USEPA (2011); Paste masks (mud packs) Bremmer et al. (2006a); Skin care - Peeling-gel Bremmer et al. (2006a); Skin care - Face pack Bremmer et al. (2006a); Facial cleanser ACI (2010); Cleansing products ACI (2010); F &H bar soap–face Wu et al. (2010); Facial cleanser (Adult) Wu et al. (2010); Mask / deep cleanser (Adult) Wu et al. (2010); Facial cleanser (Child) USEPA (2011); Loretz 2008: Facial cleanser	Prevalence estimated from Wu et al. (2010)
213	PERSONAL CARE; FOOT CARE	21.9	2	15	15	0	10	100	100	0	USEPA (2011); Foot powder and sprays Bremmer et al. (2006a); Foot care - Antiperspirant Bremmer et al. (2006a); Foot care - Anti-fungicides	Prevalence assumed

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214	PERSONAL CARE; FRAGRANCES	109.5	5	10	70	10	2	100	50	0	USEPA (2011); Colognes and toilet water USEPA (2011); Perfumes USEPA (2011); Sachets Bremmer et al. (2006a); Fragrances - Eau de toilette spray Bremmer et al. (2006a); Fragrances – Perfume ACI (2010); Fine fragrances Wu et al. (2010); Fragrance (Adult) USEPA (2011); Loretz et al. 2006: Spray perfume Bennett et al. (2012); Women's fragrance	Prevalence estimated from Wu et al. (2010)
215	PERSONAL CARE; HAIR COLOR	4	150	12	63	0	30	70	1	0	USEPA (2011); Hair dye USEPA (2011); Hair lighteners USEPA (2011); Hair bleaches USEPA (2011); Hair tints USEPA (2011); Hair rinse (coloring) Bremmer et al. (2006a); Hair care - Hair dye Bremmer et al. (2006a); Hair care - Hair bleaching products Wu et al. (2010); Hair dye (Adult) Wu et al. (2010); Hair dye (Child	Prevalence estimated from Wu et al. (2010)
216	PERSONAL CARE; HAIR RELAXER	3	100	1	18	1	30	70	1	0	USEPA (2011); Wave sets USEPA (2011); Permanent wave USEPA (2011); Hair straighteners Bremmer et al. (2006a); Hair care - Permanent wave- Perm lotion Bremmer et al. (2006a); Hair care - Permanent wave- - Fixing lotion Wu et al. (2010); Hair perm (Adult) Wu et al. (2010); Hair perm (Child)	Prevalence estimated from Wu et al. (2010)
217	PERSONAL CARE; HAIR SPRAY	182.5	5	29	70	10	5	70	100	0	USEPA (2011); Hair sprays USEPA (2011); Hair color spray Bremmer et al. (2006a); Hair care - Hairspray, aerosol can ACI (2010); Hair sprays–aerosol ACI (2010); Hair spray (pump) Wu et al. (2010); Hair spray (Adult) Wu et al. (2010); Hair spray (Child) USEPA (2011); Hair spray USEPA (2011); Loretz et al. 2006: Hairspray (aerosol) USEPA (2011); Loretz et al. 2006: Hairspray (pump)	Prevalence estimated from Wu et al. (2010)
218	PERSONAL CARE; HAIR STYLING	365	5	39	63	20	5	50	100	0	Bremmer et al. (2006a); Hair care - Hair styling, gel Bremmer et al. (2006a); Hair care - Hair styling, mousse ACI (2010); Styling tonic/gel Wu et al. (2010); Hair mousse (Adult) Wu et al. (2010); Hair mousse (Child) Bennett et al. (2012); Hair styling products	Prevalence estimated from Wu et al. (2010)

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219	PERSONAL CARE; HAND LOTION	672	2	79	95	70	5	100	100	0	USEPA (2011); Cuticle softeners Bremmer et al. (2006a); Skin care cream - Hand cream Wu et al. (2010); Hand lotion (Adult) Wu et al. (2010); Hand lotion (Child) Bennett et al. (2012); Hand sanitizer	Prevalence estimated from Wu et al. (2010)
220	PERSONAL CARE; HAND SANITIZER	547.5	5	24	87	81	2	100	1	0	Wu et al. (2010); Waterless hand sanitizer (Adult) Wu et al. (2010); Waterless hand sanitizer (Child)	
221	PERSONAL CARE; HAND SOAP	1800	10	68	75	83	2	100	1	0	Bremmer et al. (2006a); Washing hands – gel ACI (2010); F&H liquid soap–hand Wu et al. (2010); Liquid soap (antibacterial) (Adult) Wu et al. (2010); Liquid soap (not antibacterial) (Adult) Wu et al. (2010); Liquid soap (antibacterial) (Child) Bennett et al. (2012); Liquid soap Bennett et al. (2012); Antibacterial soap	Prevalence estimated from Wu et al. (2010)
222	PERSONAL CARE; JEWELRY CLEANER	12	20	1	5	0	10	1	1	0		All assumed
223	PERSONAL CARE; KID'S FRAGRANCE	52	2	0	0	15	5	100	100	0	Wu et al. (2010); Fragrance (Child)	
224	PERSONAL CARE; LICE SHAMPOO	19.2	10	1	1	5	30	50	2	0	Wu et al. (2010); Shampoo for lice (Adult) Wu et al. (2010); Shampoo for lice (Child)	
225	PERSONAL CARE; LINIMENT	30	10	20	5	5	10	100	100	0	USEPA (2011); Tonics and dressings Bremmer et al. (2006a); Essential oils - Massage	Prevalence assumed
226	PERSONAL CARE; LIPS	540	2	64	95	60	2	100	50	1	USEPA (2011); Lipstick and lip gloss Bremmer et al. (2006a); Make-up - lipstick Bremmer et al. (2006a); Make-up - lip salve ACI (2010); Lipstick ACI (2010); Lipstick Wu et al. (2010); Lip Balm/lipstick (Adult) Wu et al. (2010); Lip Balm/lipstick (Child) USEPA (2011); Loretz et al. 2005: Lipstick	Prevalence estimated from Wu et al. (2010)
227	PERSONAL CARE; MOUTHWASH	153.3	30	50	50	20	5	50	1	2	USEPA (2011); Mouthwashes USEPA (2011); Breath fresheners Bremmer et al. (2006a); Mouth wash ACI (2010); Mouthwash - Adult	Prevalence assumed
228	PERSONAL CARE; NAIL ADHESIVE	12	2	1	3	0	20	1	0.1	0		All assumed

Category Number	Product Category	Frequency FR (year^{-1})	Mass per Use (g)	Prevalence, Males (%)	Prevalence, Females (%)	Prevalence, Children < 12 (%)	Duration of Direct Use (min)	Percent of Product in Contact with skin F_{cont} (%)*	Percent Retained on Skin after Direct Use F_{ret} (%)*	Percent of Product Ingested F_{ing} (%)*	Data Sources Considered (Not all variables may be present in sources; consensus values determined using judgement)	Notes
229	PERSONAL CARE; NAIL POLISH	58.4	2	0	80	30	5	10	1	0	USEPA (2011); Nail basecoats USEPA (2011); Nail creams and lotions USEPA (2011); Nail extenders USEPA (2011); Nail polish and enamel USEPA (2011); Nail undercoats Bremmer et al. (2006a); Nail care - Nail polish Bremmer et al. (2006a); Nail care - Nail polish remover Wu et al. (2010); Nail polish (professional) (Adult) Wu et al. (2010); Nail polish (self) (Adult) Wu et al. (2010); Nail polish (self) (Child) Bennett et al. (2012); Nail polish	Prevalence estimated from Wu et al. (2010)
230	PERSONAL CARE; NAIL POLISH REMOVER	50	5	0	80	30	5	10	1	0	USEPA (2011); Nail polish and enamel remover	Prevalence assumed
231	PERSONAL CARE; SCALP TREATMENTS	52	10	20	10	0	10	100	1	0		All assumed
232	PERSONAL CARE; SELF TANNER	12	5	2	20	0	20	100	1	0		All assumed
233	PERSONAL CARE; SEXUAL WELLNESS	52	10	20	20	0	30	100	1	0		All assumed
234	PERSONAL CARE; SHAMPOO	300	20	100	100	100	10	50	1	0	USEPA (2011); Shampoos USEPA (2011); Shampoo (coloring) Bremmer et al. (2006a); Hair care – Shampoo ACI (2010); Shampoos ACI (2010); Kids shampoos Wu et al. (2010); Shampoo (Adult) Bennett et al. (2012); Shampoo and conditioner USEPA (2011); Loretz et al. 2006; Shampoo	Prevalence estimated from Wu et al. (2010)
235	PERSONAL CARE; SHAVING CREAM	365	2	80	80	5	5	50	1	0	USEPA (2011); Shave Cream Bremmer et al. (2006a); Men's cosmetics - Shaving cream ACI (2010); Shave Cream	Prevalence assumed
236	PERSONAL CARE; SUNSCREEN	300	10	88	88	100	5	100	100	0	USEPA (2011); Sunscreen Bremmer et al. (2006a); Sun care cosmetics - Sunscreen lotion Wu et al. (2010); Sunscreen - hot season (Adult) Wu et al. (2010); Sunscreen - cool season (Adult) Wu et al. (2010); Sunscreen - hot season (Child) Wu et al. (2010); Sunscreen - cool season (Child) Bennett et al. (2012); Sun block	Prevalence estimated from Wu et al. (2010)
237	PERSONAL CARE; TEETH WHITENER	12	20	20	20	0	30	50	5	1		All assumed
238	PERSONAL CARE; TONER	204.4	2	30	60	5	10	100	5	0	USEPA (2011); Skin fresheners and astringents	Prevalence assumed
239	PERSONAL CARE; TOOTHPASTE	773.8	3	100	100	100	2	50	5	5	USEPA (2011); Dentifrices Bremmer et al. (2006a); Toothpaste: Adults, children ACI (2010); Toothpaste	Prevalence assumed
240	PESTICIDES; ANIMAL REPELLENT	12	200	1	1	0	20	1	1	0		All assumed

Category Number	Product Category	Frequency FR (year^{-1})	Mass per Use (g)	Prevalence, Males (%)	Prevalence, Females (%)	Prevalence, Children < 12 (%)	Duration of Direct Use (min)	Percent of Product in Contact with skin F_{cont} (%)*	Percent Retained on Skin after Direct Use F_{ret} (%)*	Percent of Product Ingested F_{ing} (%)*	Data Sources Considered (Not all variables may be present in sources; consensus values determined using judgement)	Notes
241	PESTICIDES; FUNGICIDE	1	500	5	1	0	15	0.01	1	0	Prud'homme de Lodder et al. (2006b); Black mould removers - spray	Prevalence assumed
242	PESTICIDES; INSECT REPELLENT	12	100	40	40	40	30	0	0	0		All assumed
243	PESTICIDES; INSECT REPELLENT, EXTERIOR	12	100	40	40	40	30	0	0	0		All assumed
244	PESTICIDES; INSECT REPELLENT, SKIN	48	5	50	50	50	2	100	100	0	Wu et al. (2010); Insect repellent (Adult) Wu et al. (2010); Insect repellent (Child)	
245	PESTICIDES; INSECTICIDE	27	20	90	90	0	30	5	1	0	Bennett et al. (2012); All pesticides USEPA (2011); Insecticide	Prevalence from Bennett et al. (2012)
246	PESTICIDES; INSECTICIDE, EXTERIOR	10	500	80	80	0	30	0.1	1	0	Armes et al., PEG, (2011); Lifetime prevalence: Outdoor pesticide spray Armes et al., PEG, (2011); Lifetime prevalence: Outdoor pesticide bait Armes et al., PEG, (2011); Lifetime prevalence: Outdoor pesticide granule Armes et al., SUPERB, (2011); Prevalence in the last year: Outdoor pesticide spray Armes et al., SUPERB, (2011); Prevalence in the last year: Outdoor pesticide bait Armes et al., SUPERB, (2011); Prevalence in the last year: Outdoor pesticide granule Wu et al. (2011); Outdoor spray Wu et al. (2011); Outdoor baits Wu et al. (2011); Outdoor trap Wu et al. (2011); Outdoor granules Wu et al. (2011); Outdoor candle Wu et al. (2011); Outdoor strips Wu et al. (2011); Outdoor foam Wu et al. (2011); Outdoor other	Prevalence assumed (conservative assumption based on multiple values from sources)

Category Number	Product Category	Frequency FR ($year^{-1}$)	Mass per Use (g)	Prevalence, Males (%)	Prevalence, Females (%)	Prevalence, Children < 12 (%)	Duration of Direct Use (min)	Percent of Product in Contact with skin F_{cont} (%)*	Percent Retained on Skin after Direct Use F_{ret} (%)*	Percent of Product Ingested F_{ing} (%)*	Data Sources Considered (Not all variables may be present in sources; consensus values determined using judgement)	Notes
247	PESTICIDES; INSECTICIDE, INTERIOR	27	50	75	75	0	30	0.1	1	0	Armes et al., PEG, (2011); Lifetime prevalence: Indoor pesticide spray Armes et al., PEG, (2011); Lifetime prevalence: Indoor pesticide bait Armes et al., PEG, (2011); Lifetime prevalence: Indoor pesticide granule Armes et al., SUPERB, (2011); Prevalence in the last year: Indoor pesticide spray Armes et al., SUPERB, (2011); Prevalence in the last year: Indoor pesticide bait Armes et al., SUPERB, (2011); Prevalence in the last year: Indoor pesticide granules Armes et al., SUPERB, (2011); Prevalence in the last year: Indoor fogger Wu et al. (2011); Indoor spray Wu et al. (2011); Indoor fogger Wu et al. (2011); Indoor baits Wu et al. (2011); Indoor granules Wu et al. (2011); Indoor candle Wu et al. (2011); Indoor strips Wu et al. (2011); Indoor foam	Prevalence assumed (conservative assumption based on multiple values from sources)
248	PESTICIDES; RODENTICIDE	2	20	7	7	0	5	0.1	1	0	USEPA (2011); Rodenticide	Prevalence assumed
249	PET CARE; AQUARIUM	12	50	2	2	2	20	1	1	0		All assumed
250	PET CARE; CAT LITTER	104	8000	30	30	5	5	1	1	0		All assumed
251	PET CARE; OTHER PET TREATMENTS	12	50	10	10	1	10	1	1	0		All assumed
252	PET CARE; PESTICIDE, PET	12	5	40	40	0	2	5	1	0	Wu et al. (2011); Pet USEPA (2011); Pet	Prevalence assumed
253	PET CARE; PET SHAMPOO	12	50	10	10	0	15	5	1	0		All assumed
254	PET CARE; SPOT CLEANER	96	50	70	80	0	10	5	1	0		All assumed

*reported as %; divide by 100 to obtain value used in equations in Section A.

Table S9. Mapping of SHEDS-HT consumer product categories to exposure scenarios.

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
ARTS AND CRAFTS; ARTS AND CRAFTS ADHESIVE	X	X			
ARTS AND CRAFTS; ARTS AND CRAFTS ADHESIVE, SPRAY	X		X		X
ARTS AND CRAFTS; ARTS AND CRAFTS CLEANER	X		X		X
ARTS AND CRAFTS; ARTS AND CRAFTS FINISH	X		X		
ARTS AND CRAFTS; ARTS AND CRAFTS FRAGRANCES	X	X			
ARTS AND CRAFTS; ARTS AND CRAFTS PAINT	X	X			
ARTS AND CRAFTS; ARTS AND CRAFTS PAINT THINNER	X	X			
ARTS AND CRAFTS; ARTS AND CRAFTS PAINT, EXTERIOR	X		X		
ARTS AND CRAFTS; ARTS AND CRAFTS PAINT, SPRAY	X		X		X
ARTS AND CRAFTS; ARTS AND CRAFTS SEALANT	X		X		
ARTS AND CRAFTS; BIKE TIRE SEALER	X	X			
ARTS AND CRAFTS; BODY PAINT	X	X			
ARTS AND CRAFTS; CAMPING FUEL	X	X			
ARTS AND CRAFTS; CANDLE-MAKING	X	X			
ARTS AND CRAFTS; CERAMICS	X				
ARTS AND CRAFTS; DYE	X	X			
ARTS AND CRAFTS; FABRIC PAINTS AND SEALERS	X	X			
ARTS AND CRAFTS; FINGER PAINT	X				
ARTS AND CRAFTS; FIXATIVE	X		X		
ARTS AND CRAFTS; FLOCKING	X		X		X
ARTS AND CRAFTS; FOGGER			X		X
ARTS AND CRAFTS; GESSO	X	X			
ARTS AND CRAFTS; GLASS ETCHING/POLISHING	X	X			
ARTS AND CRAFTS; GLAZE	X	X			
ARTS AND CRAFTS; MODEL ENGINE FUEL	X	X			
ARTS AND CRAFTS; MODEL PAINT	X	X			
ARTS AND CRAFTS; OIL PAINT	X	X			
ARTS AND CRAFTS; PENS AND MARKERS	X	X			
ARTS AND CRAFTS; SOAP-MAKING	X	X			
AUTO PRODUCTS; ANTIFREEZE	X	X			
AUTO PRODUCTS; AUTO AIR FRESHENER	X	X			
AUTO PRODUCTS; AUTO DEGREASER	X	X			
AUTO PRODUCTS; AUTO FLUIDS AND ADDITIVES	X	X			
AUTO PRODUCTS; AUTO LUBRICANT	X		X		
AUTO PRODUCTS; AUTO PAINT	X		X		
AUTO PRODUCTS; BOAT CLEANER	X	X			
AUTO PRODUCTS; BOAT ENGINE FLUIDS	X	X			
AUTO PRODUCTS; BOAT PAINT	X	X			

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
AUTO PRODUCTS; BODY WASH OR WAX	X	X			
AUTO PRODUCTS; DETAILING	X	X			
AUTO PRODUCTS; MOTOR OIL	X	X			
AUTO PRODUCTS; REFRIGERANT	X	X			
AUTO PRODUCTS; TIRE REPAIR	X	X			
AUTO PRODUCTS; TRIM REPAIR	X	X			
AUTO PRODUCTS; WHEELS	X		X		
AUTO PRODUCTS; WINDOWS/WINDSHIELD	X	X			
HOME MAINTENANCE; ADHESIVE	X	X			X
HOME MAINTENANCE; ADHESIVE REMOVER	X	X			X
HOME MAINTENANCE; ADHESIVE, EXTERIOR	X	X			
HOME MAINTENANCE; BLEACHING OIL	X	X			X
HOME MAINTENANCE; CAULK	X	X			X
HOME MAINTENANCE; CAULK REMOVER	X	X			X
HOME MAINTENANCE; CAULK EXTERIOR	X	X			
HOME MAINTENANCE; CONCRETE		X			
HOME MAINTENANCE; CONCRETE ADDITIVE	X	X			
HOME MAINTENANCE; CORROSION PROTECTION	X		X		
HOME MAINTENANCE; DEGREASER	X	X			X

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
HOME MAINTENANCE; DRYWALL RETARDER	X	X			X
HOME MAINTENANCE; ELECTRONICS LUBRICANT	X	X			X
HOME MAINTENANCE; FINISH	X	X			X
HOME MAINTENANCE; FINISH GLAZE	X	X			X
HOME MAINTENANCE; FINISH HARDENER	X	X			X
HOME MAINTENANCE; FINISH SPRAY	X		X		X
HOME MAINTENANCE; FINISH, EXTERIOR	X	X			
HOME MAINTENANCE; GLAZING	X	X			X
HOME MAINTENANCE; GROUT ADDITIVE	X	X			X
HOME MAINTENANCE; GROUT HAZE REMOVER	X	X			X
HOME MAINTENANCE; GROUT SEALER	X	X			X
HOME MAINTENANCE; HOME MAINTENANCE CLEANER	X	X			X
HOME MAINTENANCE; JOINT COMPOUND	X				X
HOME MAINTENANCE; LACQUER	X	X			X
HOME MAINTENANCE; LOCK DEICER	X		X		
HOME MAINTENANCE; LUBRICANT	X		X		X
HOME MAINTENANCE; MORTAR OR GROUT	X	X			X
HOME MAINTENANCE; MULTIPURPOSE ADHESIVE	X	X			
HOME MAINTENANCE; PAINT	X	X			X

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
HOME MAINTENANCE; PAINT ADDITIVE	X	X			X
HOME MAINTENANCE; PAINT CLEANER	X	X			
HOME MAINTENANCE; PAINT TEXTURE	X	X			X
HOME MAINTENANCE; PAINT THINNER	X	X			X
HOME MAINTENANCE; PAINT, EXTERIOR	X	X			
HOME MAINTENANCE; PAINT, INTERIOR	X	X			X
HOME MAINTENANCE; PAINT, SPRAY	X		X		X
HOME MAINTENANCE; PATCH AND REPAIR	X	X			X
HOME MAINTENANCE; PLASTER	X	X			
HOME MAINTENANCE; PLUMBING	X	X			
HOME MAINTENANCE; PORCELAIN	X	X			
HOME MAINTENANCE; PRESTAIN PRODUCTS	X	X			X
HOME MAINTENANCE; PRIMER	X		X		X
HOME MAINTENANCE; PRIMER, SPRAY	X		X		X
HOME MAINTENANCE; PUTTY OR FILLER	X	X			X
HOME MAINTENANCE; ROOF	X	X			
HOME MAINTENANCE; SEALANT	X	X			X
HOME MAINTENANCE; SEALER, EXTERIOR	X	X			
HOME MAINTENANCE; SOLDER	X	X			
HOME MAINTENANCE; SPRAY FOAM	X	X			X
HOME MAINTENANCE; STAIN	X	X			X

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
HOME MAINTENANCE; STAIN, EXTERIOR	X	X			
HOME MAINTENANCE; STAIN, SPRAY	X		X		X
HOME MAINTENANCE; STRIPPER	X	X			X
HOME MAINTENANCE; STRIPPER, EXTERIOR	X	X			
HOME MAINTENANCE; STUCCO REPAIR	X	X			
HOME MAINTENANCE; SUPER GLUE	X	X			
HOME MAINTENANCE; SURFACE PROTECTANT	X	X			X
HOME MAINTENANCE; SURFACE SEALER	X	X			X
HOME MAINTENANCE; WELDING	X	X			
HOME MAINTENANCE; WOOD PRESERVATIVE	X	X			
HOME MAINTENANCE; WOOD ADHESIVE	X	X			X
HOME OFFICE; INK	X				
HOME OFFICE; PRINTER INK/TONER			X		
HOME OFFICE; WHITE OUT	X	X			
INSIDE THE HOME; AIR FRESHENER			X		X
INSIDE THE HOME; ANTI-STATIC SPRAY	X		X		X
INSIDE THE HOME; AUTOMATIC DISHWASHING	X	X			
INSIDE THE HOME; AUTOMATIC DISHWASHING DETERGENT	X	X			
INSIDE THE HOME; BATHROOM CLEANER	X		X		X

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
INSIDE THE HOME; BLEACH	X	X			X
INSIDE THE HOME; CARPET CLEANER	X		X		X
INSIDE THE HOME; CARPET DEODORIZER	X	X			X
INSIDE THE HOME; CLEANER	X		X		X
INSIDE THE HOME; DISH SOAP	X	X			
INSIDE THE HOME; DISINFECTANT	X		X		X
INSIDE THE HOME; DISINFECTANT SPRAY	X		X		X
INSIDE THE HOME; DRAIN	X	X			
INSIDE THE HOME; DRY CLEANER			X		
INSIDE THE HOME; ELECTRONICS CLEANER	X		X		X
INSIDE THE HOME; FABRIC DEODORIZER	X		X		X
INSIDE THE HOME; FABRIC PROTECTANT	X		X		X
INSIDE THE HOME; FABRIC SOFTENER	X	X			
INSIDE THE HOME; FIREPLACE	X	X			X
INSIDE THE HOME; FLOOR CLEANER	X	X			X
INSIDE THE HOME; FLOOR POLISH	X	X			X
INSIDE THE HOME; FLOOR SEALER	X	X			X
INSIDE THE HOME; FURNITURE WAX	X	X			X
INSIDE THE HOME; GARBAGE DISPOSAL DEODORIZER	X	X			
INSIDE THE HOME; GLASS CLEANER	X		X		X
INSIDE THE HOME; GROUT CLEANER	X		X		X

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
INSIDE THE HOME; GUM REMOVER	X	X			X
INSIDE THE HOME; HAND CLEANER	X				
INSIDE THE HOME; HOUSEPLANT CARE	X		X		X
INSIDE THE HOME; LAMP OIL/LIGHTER FLUID	X	X			
INSIDE THE HOME; LAUNDRY DETERGENT	X	X			
INSIDE THE HOME; LAUNDRY STAIN REMOVER	X		X		
INSIDE THE HOME; LAUNDRY STARCH	X		X		
INSIDE THE HOME; LEATHER CLEANER	X		X		X
INSIDE THE HOME; LIME REMOVER	X	X			
INSIDE THE HOME; METAL POLISH	X	X			X
INSIDE THE HOME; OVEN CLEANER			X		
INSIDE THE HOME; PRODUCE CLEANER	X			X	
INSIDE THE HOME; SHOE POLISH OR PROTECTANT	X		X		
INSIDE THE HOME; SILVER CLEANER	X	X			
INSIDE THE HOME; STARCH	X		X		X
INSIDE THE HOME; SURFACE CLEANER	X		X		X
INSIDE THE HOME; UPHOLSTERY CLEANER	X		X		X
INSIDE THE HOME; WASHING MACHINE CLEANER	X	X			
INSIDE THE HOME; WAX REMOVER	X	X			X
INSIDE THE HOME; WOOD POLISH	X		X		X

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
LANDSCAPE/YARD; CLEANER, EXTERIOR	X	X			
LANDSCAPE/YARD; COMPOST	X				
LANDSCAPE/YARD; COMPOST TREATMENTS	X	X			
LANDSCAPE/YARD; FERTILIZER	X				
LANDSCAPE/YARD; GARDEN CARE, OTHER	X	X			
LANDSCAPE/YARD; GARDEN FERTILIZER	X	X			
LANDSCAPE/YARD; GRILL FUEL		X			
LANDSCAPE/YARD; HERBICIDE	X		X		
LANDSCAPE/YARD; HOT TUB/SPA CHEMICALS	X				
LANDSCAPE/YARD; HUMUS	X				
LANDSCAPE/YARD; LAWN CARE, OTHER	X		X		
LANDSCAPE/YARD; LAWN FERTILIZER	X		X		
LANDSCAPE/YARD; LAWN FUNGICIDE	X		X		
LANDSCAPE/YARD; LAWN SEED	X				
LANDSCAPE/YARD; LAWNMOVER FLUIDS	X	X			
LANDSCAPE/YARD; MULCH	X				
LANDSCAPE/YARD; POND TREATMENTS	X	X			
LANDSCAPE/YARD; POOL CHEMICALS	X	X			
LANDSCAPE/YARD; POTTING SOIL	X				
LANDSCAPE/YARD; SKUNK ODOR REMOVER	X				

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
LANDSCAPE/YARD; SURFACE DEICER	X	X			
LANDSCAPE/YARD; TOOL LUBRICANT	X	X			
LANDSCAPE/YARD; TOPSOIL	X				
LANDSCAPE/YARD; TREES	X	X			
PERSONAL CARE; AFTERSHAVE	X	X			
PERSONAL CARE; BABY CONDITIONER	X	X			
PERSONAL CARE; BABY LOTION	X	X			
PERSONAL CARE; BABY POWDER	X	X			
PERSONAL CARE; BABY SHAMPOO	X	X			
PERSONAL CARE; BABY WASH	X	X			
PERSONAL CARE; BABY WIPES	X				
PERSONAL CARE; BAR SOAP	X	X			
PERSONAL CARE; BATH OIL	X	X			
PERSONAL CARE; BODY HAIR BLEACH	X	X			
PERSONAL CARE; BODY LOTION	X	X			
PERSONAL CARE; BODY MAKEUP	X				
PERSONAL CARE; BODY POWDER	X	X			
PERSONAL CARE; BODY WASH	X	X			
PERSONAL CARE; BODY WIPES	X	X			
PERSONAL CARE; BUBBLE BATH	X		X		
PERSONAL CARE; CLIPPER LUBRICANT	X	X			

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
PERSONAL CARE; CONDITIONER	X	X			
PERSONAL CARE; CONTACT CLEANER	X				
PERSONAL CARE; DENTURE PRODUCTS	X			X	
PERSONAL CARE; DEODORANT	X		X		
PERSONAL CARE; DEPILATORY	X	X			
PERSONAL CARE; DIAPER CREAM	X				
PERSONAL CARE; EYE MAKEUP	X				
PERSONAL CARE; EYE PRODUCTS, OTHER	X				
PERSONAL CARE; FACE CREAM	X	X			
PERSONAL CARE; FACE MAKEUP	X				
PERSONAL CARE; FACE WASH	X				
PERSONAL CARE; FOOT LOTION	X		X		
PERSONAL CARE; FRAGRANCES	X		X		
PERSONAL CARE; HAIR COLOR	X	X			
PERSONAL CARE; HAIR RELAXER	X	X			
PERSONAL CARE; HAIR SPRAY	X		X		
PERSONAL CARE; HAIR STYLING	X	X			
PERSONAL CARE; HAND LOTION	X				
PERSONAL CARE; HAND SANITIZER	X				
PERSONAL CARE; HAND SOAP	X				
PERSONAL CARE; JEWELRY CLEANER	X	X			

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
PERSONAL CARE; KID'S FRAGRANCE	X		X		
PERSONAL CARE; LICE SHAMPOO	X	X			
PERSONAL CARE; LINIMENT	X	X			
PERSONAL CARE; LIPS	X			X	
PERSONAL CARE; MOUTHWASH	X			X	
PERSONAL CARE; NAIL POLISH	X	X			
PERSONAL CARE; NAIL POLISH REMOVER	X	X			
PERSONAL CARE; SHAMPOO	X				
PERSONAL CARE; SHAVING CREAM	X				
PERSONAL CARE; SUNSCREEN	X				
PERSONAL CARE; TEETH WHITENER	X			X	
PERSONAL CARE; TONER	X	X			
PERSONAL CARE; TOOTHPASTE	X			X	
PESTICIDES; ANIMAL REPELLENT	X		X		
PESTICIDES; FUNGICIDE	X	X			
PESTICIDES; INSECT REPELLENT		X			
PESTICIDES; INSECT REPELLENT, EXTERIOR		X			
PESTICIDES; INSECT REPELLENT, SKIN	X		X		
PESTICIDES; INSECTICIDE	X		X		X
PESTICIDES; INSECTICIDE, EXTERIOR	X		X		X
PESTICIDES; INSECTICIDE, INTERIOR	X		X		X

Upper Level Category; Product Category	Direct Dermal	Direct Inhalation of Vapor	Direct Inhalation of Aerosol	Direct Incidental Ingestion	Indirect
PESTICIDES; RODENTICIDE	X	X			X
PET CARE; AQUARIUM	X				
PET CARE; CAT LITTER	X	X			
PET CARE; OTHER PET TREATMENTS	X	X			
PET CARE; PESTICIDE, PET	X				X
PET CARE; PET SHAMPOO	X	X			
PET CARE; SPOT CLEANER	X		X		X

F. Chemicals with Highest Predicted Exposures

Table S10. Chemicals having highest predicted exposures in the SHEDS-HT case study.

CAS	Name	Median Intake Dose (mg/kg/day)	Number of Consumer Product Categories Containing Chemical
56-81-5	Glycerol	0.17662	90
7695-91-2	DL-α-Tocopherol acetate	0.13012	46
8009-03-8	Petrolatum	0.10205	32
64-17-5	Ethanol	0.06239	122
57-11-4	Stearic acid	0.05481	44
151-21-3	Sodium lauryl sulfate	0.02697	53
128-44-9	Saccharin sodium salt	0.01459	12
112-92-5	Octadecan-1-ol	0.01233	28
36653-82-4	Cetyl alcohol	0.01009	42
58-95-7	Tocopheryl acetate	0.00827	32
8002-74-2	Paraffin waxes and Hydrocarbon waxes	0.00746	26
50-70-4	D-Sorbitol	0.00724	39
57-55-6	1,2-Propanediol	0.00426	122
11138-66-2	Xanthan gum	0.00152	39
3844-45-9	Dihydrogen (ethyl)[4-[4-[ethyl(3-sulphonatobenzyl)	0.00081	47
77-92-9	Citric Acid	0.00071	84
497-19-8	Sodium carbonate	0.00062	39
9006-65-9	Dimethicone	0.00059	45
75-28-5	Isobutane	0.00055	100
9004-82-4	Poly(oxy-1,2-ethanediyl), ?-sulfo-?-(dodecyloxy)-,	0.00047	46
64-02-8	EDTA, tetrasodium	0.00045	67
94-13-3	Propyl 4-hydroxybenzoate	0.00043	57
67-63-0	Isopropyl alcohol	0.00034	123
122-99-6	Ethylene glycol monophenyl ether	0.00033	54
74-98-6	Propane	0.00031	116

G. Supplemental Figures

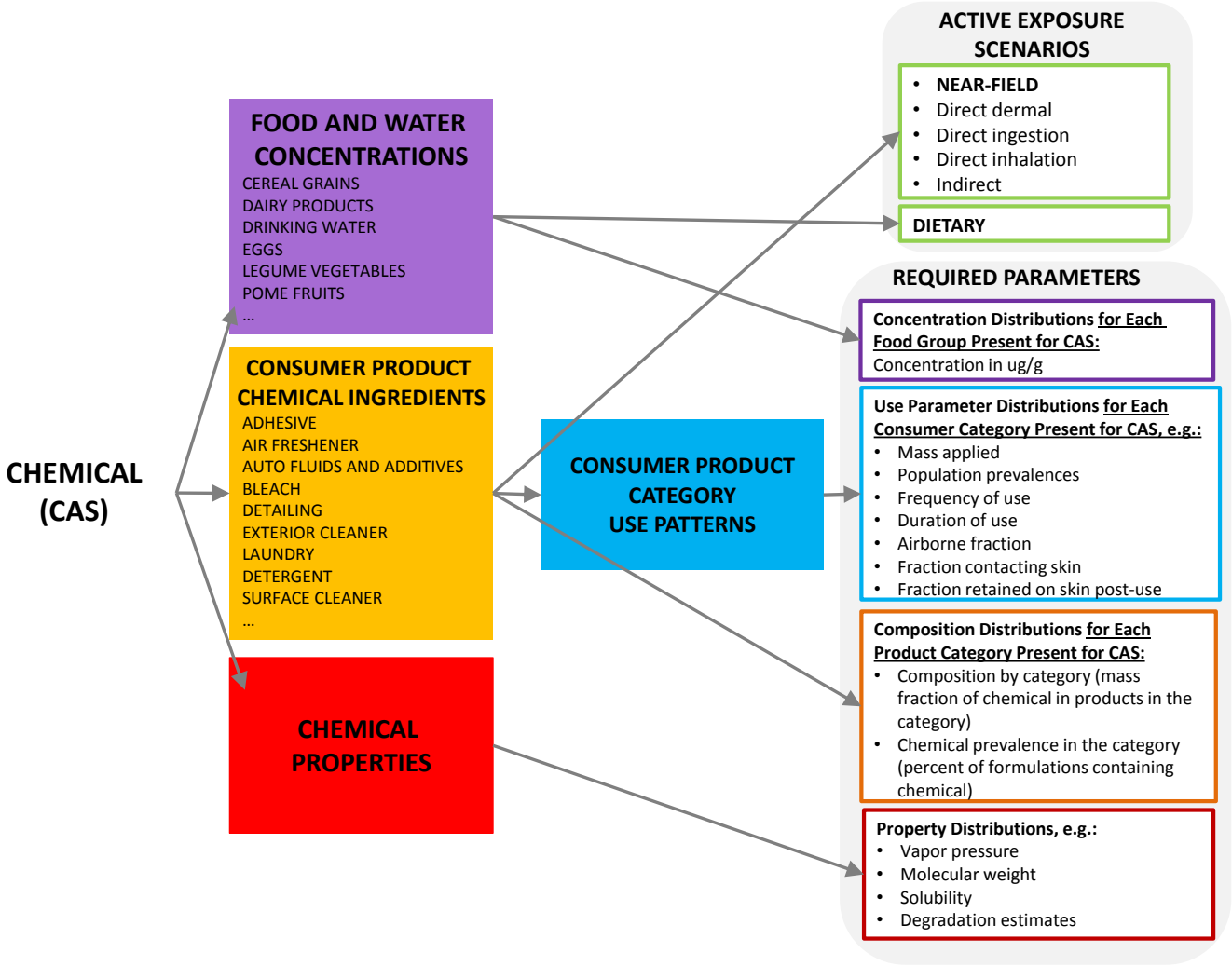

Figure S1. Parameterization of SHEDS-HT for a chemical (CAS) from the input databases. A CAS may be associated with one or more consumer product categories, each corresponding to one or more active near-field exposure scenarios and composition information. The required use patterns (and parameters) are specific to each category. A CAS number may also be associated concentrations in different food groups or drinking water, which results in an active dietary exposure scenario. Chemicals are also linked by CAS number to estimated physical-chemical properties.

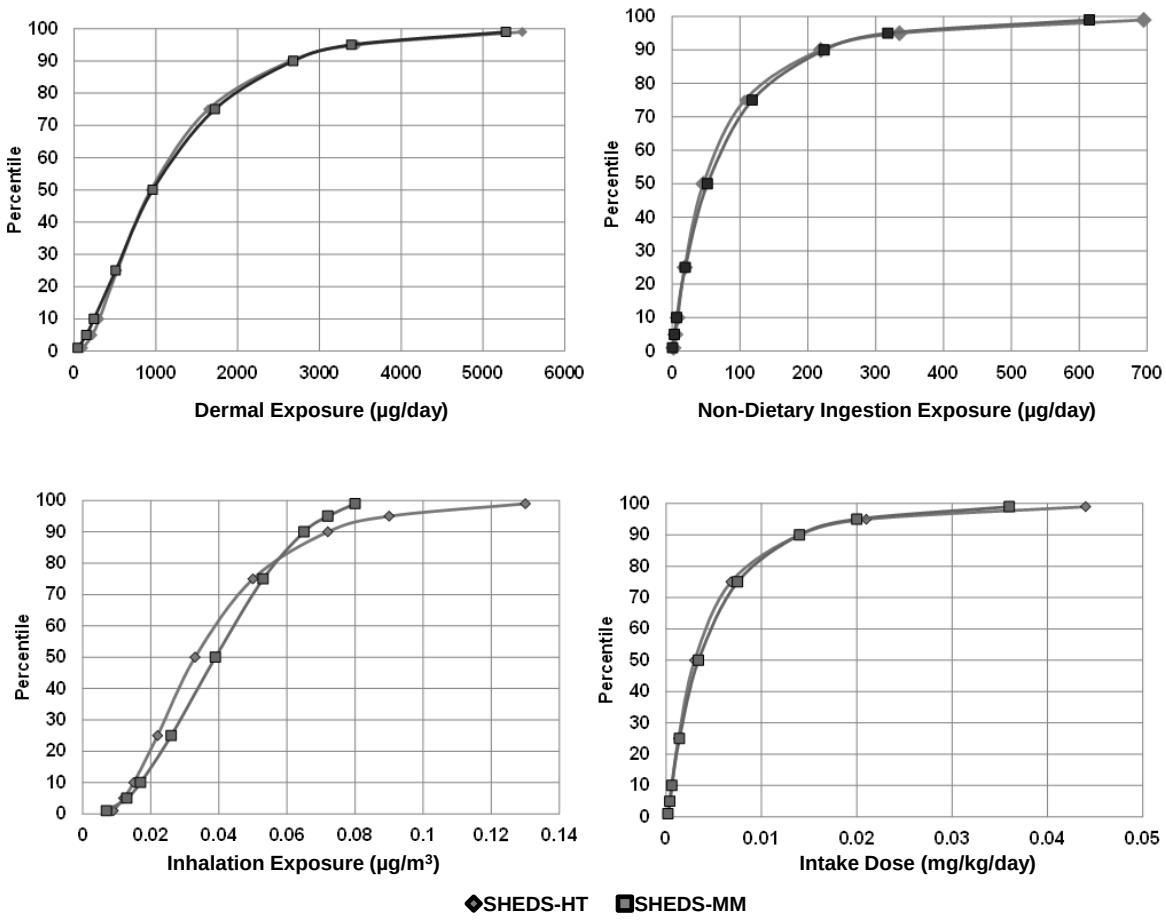

Figure S2. SHEDS-HT (HT) versus SHEDS-Multimedia (MM) results for average daily exposures and intake dose (mg/kg/day) for a case study run for permethrin.
Run consisted of 1000 simulated individuals in each case, using the same distribution of input media concentrations for a crack-crevice application.

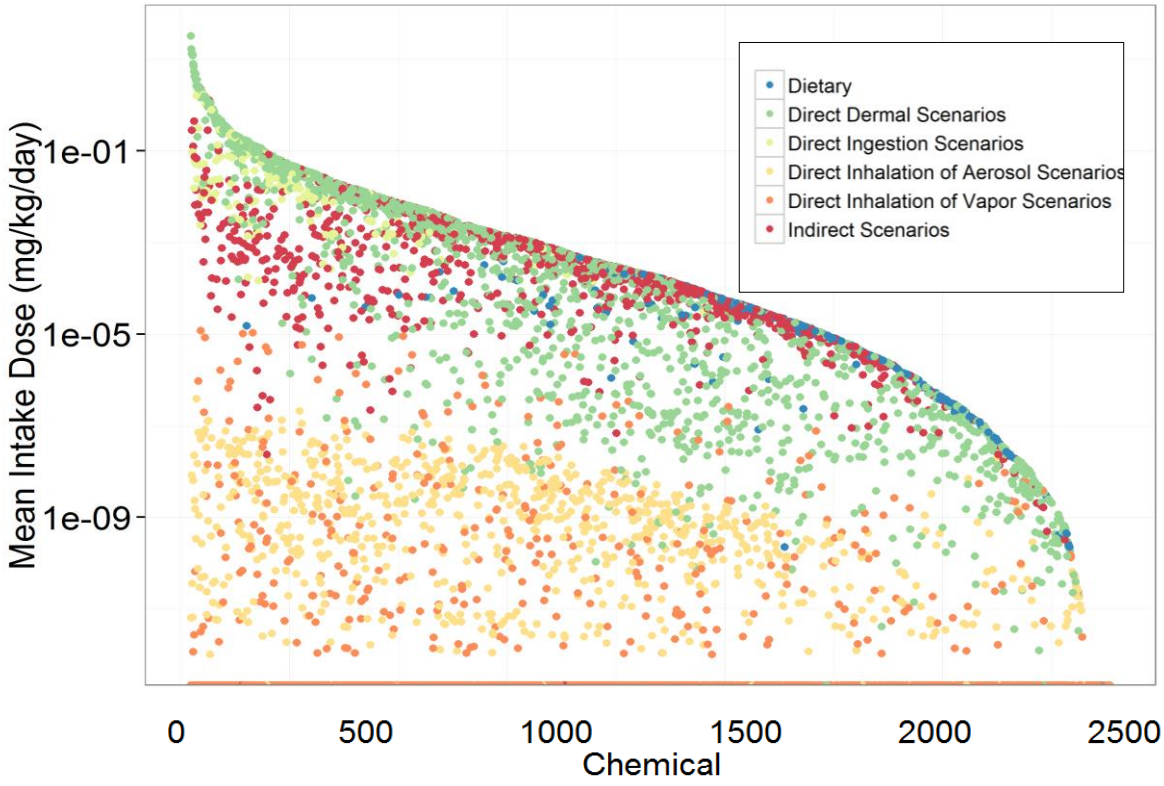

Figure S3. Population mean intake doses (μg/day) across chemicals for the various SHEDS-HT exposure scenarios.

Plotted values reflect intakes due to all consumer product categories for the near-field scenarios and all food groups for the dietary scenario**.**

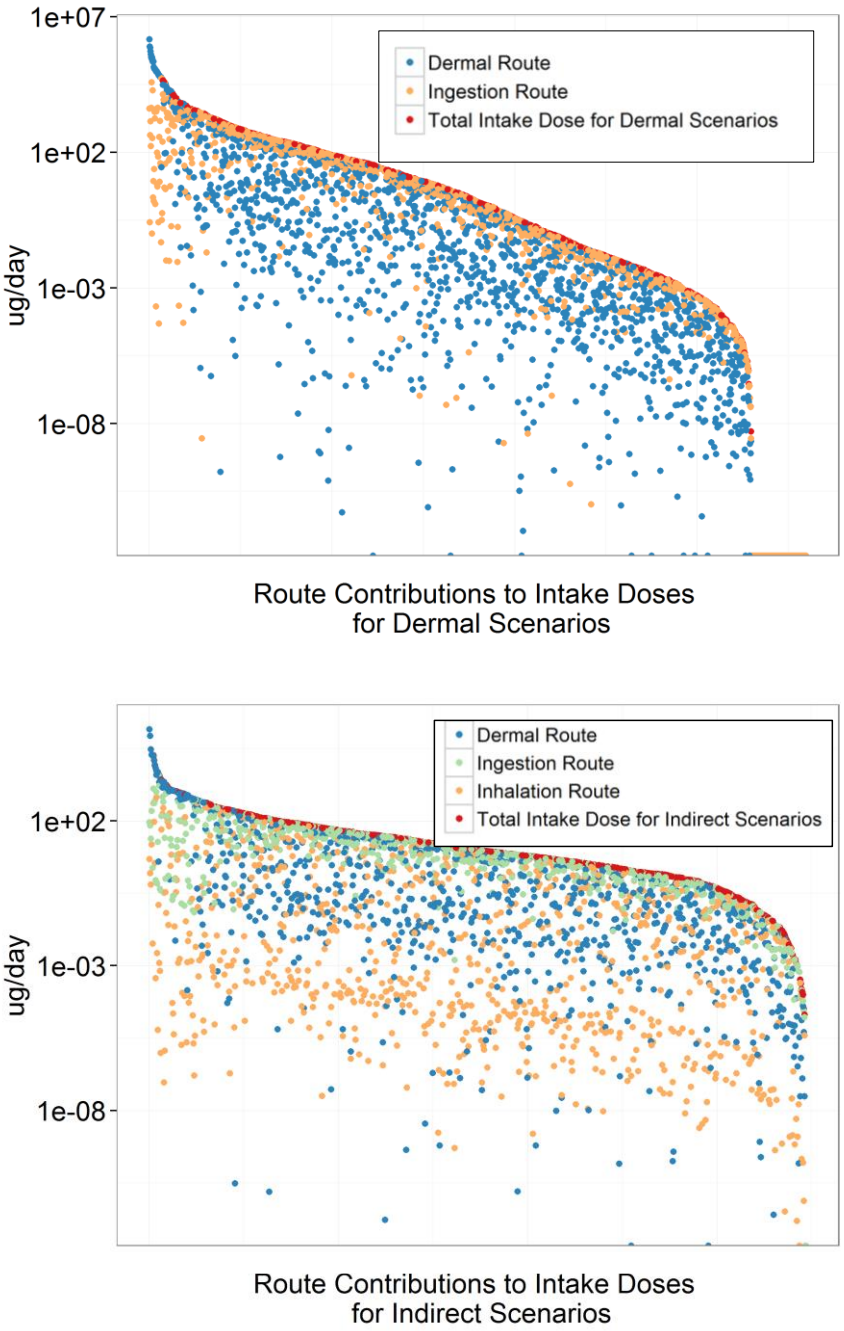

Figure S4. Contribution by exposure route to mean intake doses (μg/day) via direct dermal exposure scenarios (top) and indirect exposure scenarios (bottom).
Dermal exposure scenarios result in intake via dermal and hand-to-mouth ingestion routes, while indirect exposure scenarios result in dermal, hand-to-mouth and object-to-mouth ingestion, and inhalation. Note that not all chemicals have exposure via these scenarios (see Table S6 for chemical counts for these scenarios).

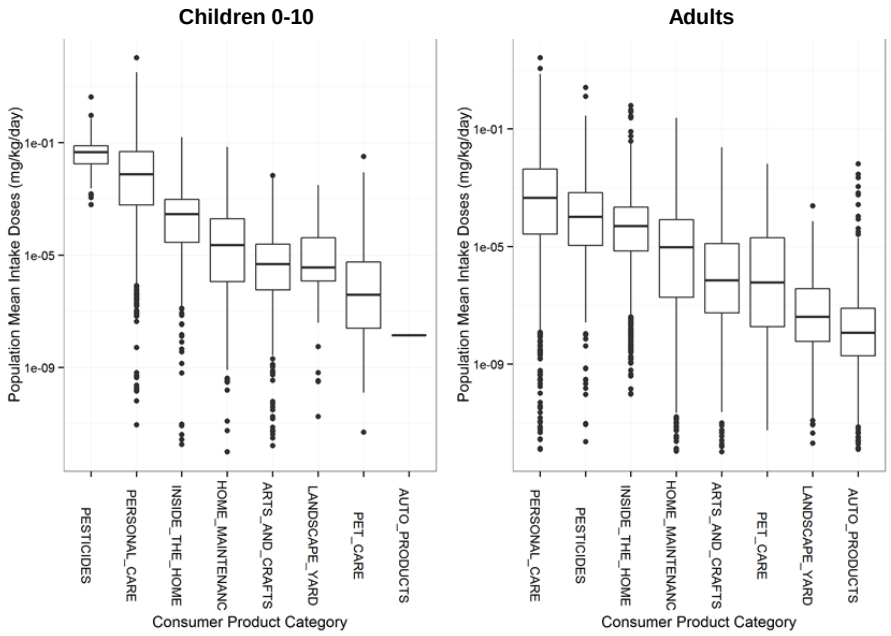

Figure S5. Distribution across chemicals of predicted mean chemical intake doses for general (broad) consumer product categories.

Boxplots illustrate distribution of population mean doses across all chemicals present in products in the broad categories. Category "Inside the Home" primarily contains cleaning products. See Table S8 for categories.

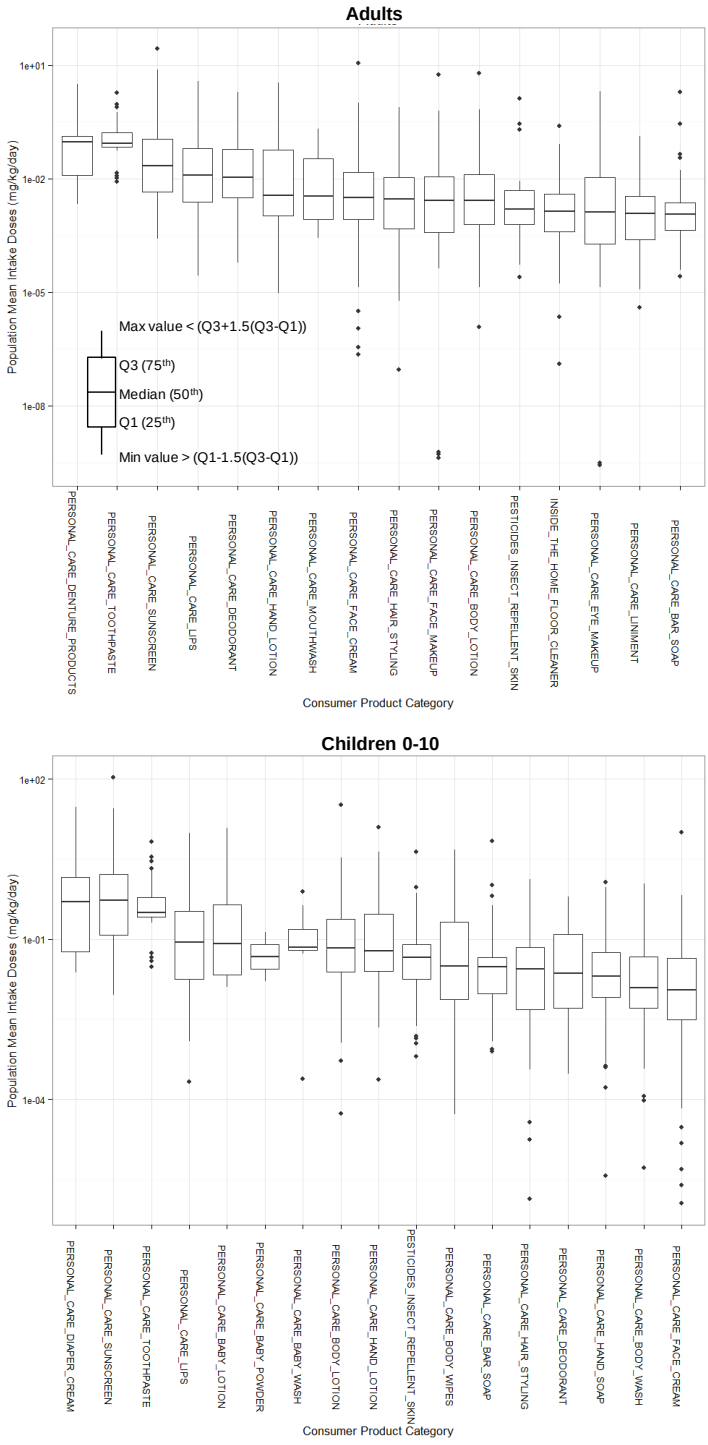

Figure S6. Consumer product categories resulting in the highest mean population intake doses for adults and for children age 0-10.

Boxplots illustrate distribution of mean doses across chemicals.

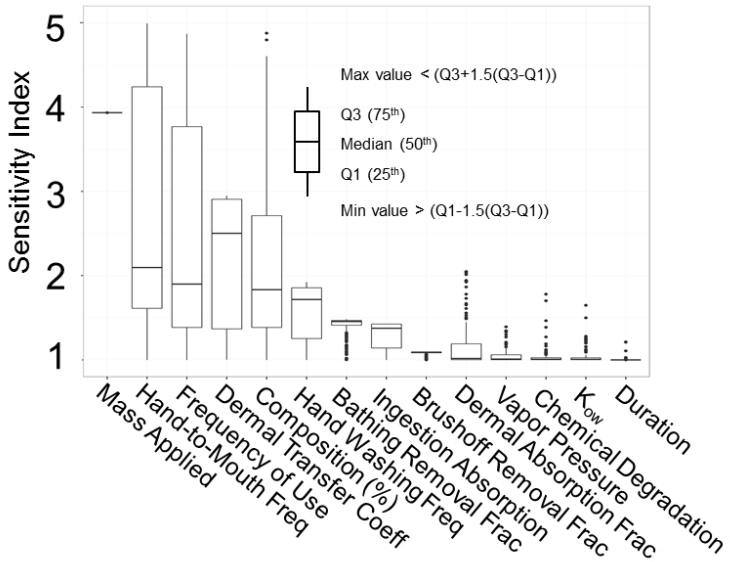

Figure S7. Sensitivity results for SHEDS-HT model predictions.
Plots show distribution of chemical-specific maximum sensitivity index (maximum ratio of population median doses at base run to population median doses at high or low parameter values) for key model parameters for total intake doses (mg/kg/day).

References

American Cleaning Institute. Consumer Product Ingredient Safety: Exposure and Risk Screening Methods for Consumer Product Ingredients. 2nd Edition; Washington, DC, 2010.

Armes, M. N.; Liew, Z.; Wang, A.; Wu, X.; Bennett, D. H.; Hertz-Picciotto, I.; Ritz, B. Residential pesticide usage in older Adults residing in Central California. Int. J. Environ. Res. Public Health 2011, 8, 3114-33.

Bennett, D. H.; Furtaw, E. J., Jr., Fugacity-based indoor residential pesticide fate model. *Environ. Sci. Technol.* **2004**, *38*, 2142.

Bennett, D. H.; Wu, X. M.; Teague, C. H.; Lee, K.; Cassady, D. L.; Ritz, B.; Hertz-Picciotto, I. Passive sampling methods to determine household and personal care product use. *J. Exposure Sci. Environ. Epidemiol.* **2012**, *22*, 148-160.

Bremmer, H.; Prud'homme de Lodder, L.; Van Engelen, J. *Cosmetics Fact Sheet. To assess the risks for the consumer. Updated version for ConsExpo 4*. RIVM report 320104001/2006; National Institute for Public Health and the Environment: Bilthoven, The Netherlands, 2006a.

Bremmer, H.; van Veen, M. Children's Toys Fact Sheet. *To assess the risks for the consumer*. RIVM report 612810012/2002; National Institute for Public Health and the Environment: Bilthoven, The Netherlands, 2002.

Bremmer, H.; van Engelen J. *Paint Products Fact Sheet: To assess the risks for the consumer. Updated version for ConsExpo 4.* RIVM report 320104008/2007; National Institute for Public Health and the Environment: Bilthoven, The Netherlands, 2007.

Bremmer, H.; Blom, W.; van Hoeven-Arentzen, P.; Prud'homme de Lodder, L.; van Raaij, M.; Straetmans, E.; van Veen, M.; van Engelen, J. *Pest Control Products Fact Sheet To assess the risks for the consumer Updated version for ConsExpo 4.* RIVM report 320005002/2006; National Institute for Public Health and the Environment: Bilthoven, The Netherlands, 2006a.

Delmaar, J.; Park, M.; van Engelen, J. ConsExpo 4.0 Consumer Exposure and Uptake Models Program Manual. RIVM report 320104004/2005; National Institute for Public Health and the Environment: Bilthoven, The Netherlands, 2005.

Glen, G.; Isaacs K. Estimating Sobol sensitivity indices using correlations. *Environ. Model. Softw.* **2012,** *37*,157–166.

Glen, G; Zartarian, V.; Smith, L.; Xue, J. *The Stochastic Human Exposure and Dose Simulation Model for Multimedia, Multipathway Chemicals (SHEDS-Multimedia): Residential Module. SHEDS-Residential version 4. Technical Manual*. Office of Research and Development, US EPA: Research Triangle Park, NC; http://www.epa.gov/heasd/research/sheds/user_information.html, 2012.

Goldsmith, M. R.; Grulke, C. M.; Brooks, R. D.; Transue, T. R.; Tan, Y. M.; Frame, A.; Egeghy, P. P.; Edwards, R.; Chang, D. T.; Tornero-Velez, R.; Isaacs, K.; Wang, A.; Johnson, J.; Holm, K.; Reich, M.; Mitchell, J.; Vallero, D. A.; Phillips, L.; Phillips, M.; Wambaugh, J. F.; Judson, R. S.; Buckley, T. J.;

Dary, C. C. Development of a consumer product ingredient database for chemical exposure screening and prioritization. *Food Chem. Toxicol*. **2014,** *65*, 269-279.

Loretz, L.; Api, A.; Barraj, L.; Burdick, J.; Davis, D.; Dressler, W.; Gilberti, E.; Jarrett, G.; Mann, S.; Pan, Y.; Re, T.; Renskers, K.; Scrafford, C.; Vater, S. Exposure data for personal care products: hairspray, spray perfume, liquid foundation, shampoo, body wash, and solid antiperspirant. *Food Chem. Toxicol.*, **2006**, *44*, 2008-2018.

Loretz, L.; Api, A.; Babcock, L.; Barraj, L.; Burdick, J.; Dressler, W.; Gettings, S.; Hsu, H; Pan, Y.; Re, T.; Renskers, K.; Rothenstein, A.; Scrafford, C.; Sewall, C. Exposure data for cosmetic products: lipstick, body lotion, and face cream. *Food Chem. Toxicol.* **2005**, *43*, 279-291.

Loretz, L.; Api, A.; Babcock, L.; Barraj, L.; Burdick, J.; Cater, K.; Jarrett, G.; Mann, S.; Pan, Y.; Re, T.; Renskers, K.; Scrafford, C. Exposure data for cosmetic products: facial cleanser, hair conditioner, and eye shadow. *Food Chem. Toxicol.*, **2008**, *46*, 1516-1524Moran, R.; Bennett, D.; Tancredi, D.; Wu, X.; Ritz, B. Hertz-Picciotto, I. Frequency and longitudinal trends of household care product use. Atmos. Env. 2012, 55, 417.

McCurdy, T.; Glen, G.; Smith, L.; Lakkadi Y. The National Exposure Research Laboratory's Consolidated Human Activity Database. J. *Exp. Anal. Environ. Epidemiol.* **2000**, *10*, 566-578

National Library of Medicine. The Household Products Database Home Page. http://householdproducts.nlm.nih.gov/, 2014.

The Nordic Council of Ministers. *Existing Default Values and Recommendations for Exposure Assessment; A Nordic Exposure Group Project*; Copenhagen, Denmark, 2011.

Prud'homme de Lodder, L.; Bremmer, H.; Van Engelen, J. *Cleaning Products Fact Sheet. To assess the risks for the consumer*. RIVM report 320104003/2006; National Institute for Public Health and theEnvironment: Bilthoven, The Netherlands, 2006a.

Prud'homme de Lodder, L.; Bremmer, H.; Pelgrom, M.; Park J.; Van Engelen, *J. Disinfectant Products Fact Sheet. To assess the risks for the consumer.* RIVM report 320005003/2006; National Institute for Public Health and the Environment: Bilthoven, The Netherlands, 2006b.

Sathyanarayana, S; Karr, CJ; Lozano, P; Brown, E; Calafat, AM; Liu, F; Swan, SH. Baby care products: possible sources of infant phthalate exposure. *Pediatrics*, **2008**, *121*, e260-e268.

ter Berg, W.; Bremmer, H.; Van Engelen, J., *Do-It-Yourself Products Fact Sheet. To assess the risks for the consumer*. RIVM report 320104007/2007. National Institute for Public Health and the Environment: Bilthoven, The Netherlands, 2007.

U.S. Department of Agriculture (USDA). *What We Eat in America, NHANES 1999-2006*;, Agricultural Research Service, Beltsville Human Nutrition Research Center, Food Surveys Research Group and U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics: Hyattsville, MD; http://www.cdc.gov/nchs/nhanes/wweia.htm, 2014a.

United States Department of Agriculture, Pesticide Data Program. http://www.ams.usda.gov/AMSv1.0/pdp., 2014b.

United States Environmental Protection Agency (EPA). The Consolidated Human Activity Database. http://www.epa.gov/heasd/chad.html, 2014.

US Census Bureau. 2000 Census of Population and Housing. https://www.census.gov/. 2000.

United States Environmental Protection Agency (EPA). Estimation Programs Interface Suite™ for Microsoft® Windows, v 4.11. United States Environmental Protection Agency, Washington, DC, USA. Available at: http://www.epa.gov/oppt/exposure/pubs/episuite.htm, 2012.

United States Environmental Protection Agency (EPA). Exposure Factors Handbook 2011 Edition. EPA/600/R-09/052F; United States Environmental Protection Agency: Washington, DC, 2011.

United States Environmental Protection Agency (EPA). *Household Solvent Products: A National Usage Survey*. EPA-OTS 560/5-87-005. United States Environmental Protection Agency: Washington, DC, 1987.

Wu, X. M.; Bennett, D. H.; Ritz, B.; Cassady, D. L.; Lee, K.; Hertz-Picciotto, I. Usage pattern of personal care products in California households. *Food Chem. Toxicol*. **2010**, *48*, 3109-3119.

Wu, X. M.; Bennett, D. H.; Ritz, B.; Frost, J; Cassady D.; Lee, K; Hertz-Picciotto, I., Residential insecticide usage in northern California homes with young children. *J Exp. Sci. and Env. Epidemiol*. **2011**, *21*, 427-436.

Xue, J.; Zartarian, V. G.; Özkaynak, H.; Dang, W.; Glen, G.; Smith, L.; Stallings, C., A probabilistic arsenic exposure assessment for children who contact chromated copper arsenate (CCA)-treated playsets and decks, Part 2: Sensitivity and uncertainty analyses. *Risk Anal.* **2006,** *26*, 533-541.

Xue, J.; Zartarian, V.; Wang, S. W.; Liu, S. V.; Georgopoulos, P. Probabilistic modeling of dietary arsenic exposure and dose and evaluation with 2003-2004 NHANES data. *Environ. Health Perspect.* **2010,** *118*, 345-350.

Xue, J.; Zartarian, V. G.; Liu, S. V.; Geller, A. M. Methyl mercury exposure from fish consumption in vulnerable racial/ethnic populations: probabilistic SHEDS-Dietary model analyses using 1999-2006 NHANES and 1990-2002 TDS data. *Sci. Total Environ.* **2012,** *414*, 373-379.

Zartarian, V.; Xue, J.; Glen, G.; Smith, L.; Tulve, N.; Tornero-Velez, R. Quantifying children's aggregate (dietary and residential) exposure and dose to permethrin: application and evaluation of EPA's probabilistic SHEDS-Multimedia model. *J. Exposure Sci. Environ. Epidemiol.* **2012,** *22*, 267-273.