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The University of Arizona
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Standard Operating Procedure **SOP-IIT-A-14.0**

Title: Probabilistic Approach for Estimating Inhalation Exposures to Chlorpyrifos and Diazinon

Source: The University of Arizona

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Office of Research and Development
Human Exposure & Atmospheric Sciences Division
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STANDARD OPERATING PROCEDURE FOR PROBABILISTIC APPROACH FOR ESTIMATING INHALATION EXPOSURES TO CHLORPYIFOS AND DIAZINON

This Standard Operating Procedure (SOP) uses data that have been properly coded and certified with appropriate QA/QC procedures by the University of Arizona NHEXAS team.

Objective

Calculate the inhalation exposure to chlorpyrifos and diazinon using the probabilistic approach.

Introduction to Probabilistic Approach of Exposure Calculation

The probabilistic approach refers to the use of the Monte Carlo simulation to estimate exposure levels based on deterministic exposure calculation equations.

Most real-world problems involving elements of uncertainty are too complex to be solved by strict analytical methods. There are simply too many combinations of input values to calculate every possible result. Monte Carlo simulation is an efficient technique for analyzing these types of problems. It is simple technique that requires only a random number table or a random number generator on a computer.

The software used for this approach in this SOP is Crystal Ball. When a simulation is run, Crystal Ball uses the Monte Carlo method to generate random numbers for the assumption cells that conform to real-life possibilities. Each set of random numbers effectively simulates a single "what-if" scenario of interest. As the simulation runs, the model is recalculated for each scenario and results are dynamically displayed in a forecast chart. The final forecast chart reflects the combined uncertainty of the assumption cells on the model's output.

Each variable needs an assumption regarding its distribution and characteristic. The concentration variables use the optimum fit distribution obtained from the Distributional Method explained in SOP#4. Other variables use distributions specified by using values from reference papers. Two types of variables are used:

- uncertainty variable is a variable that is uncertain because of insufficient information about its true, but unknown, value.
- variability variable is a variable that describes the variation in a population.

Simulations that use both types of variables are called 2-D simulations. A 2-D simulation will result in a family of forecast distributions. The standard error of a particular percentile of the forecast distribution can then be estimated.

Deterministic Exposure Calculation

The content of this section is taken from SOP#5 which explain the deterministic exposure calculation of inhalation exposure.

The equation to be used for calculating exposure values via the inhalation route to pesticides is:

(11-1)

where:

is the concentration of the i th pesticide, associated with the i th subject at the j th microenvironment.
is the time spent by the i th subject in the j th microenvironment.

The unit for exposure to each of the airborne pesticides is $(ng/m^3)(hr)$. At this stage of paper development, we do not intend to calculate the average Daily Dose though such calculations are not difficult.

The majority of the outdoor air concentration values in the NHEXAS Arizona are nondetectable. In addition, the number of detected samples are very small. Out of 42 households sampled, there are only 4 samples above the detection limit for Chlorpyrifos and only 9 samples above the detection limit for Diazinon. Therefore, the exposure to the chemicals in outdoor air is assumed to be equal to zero and the calculation in this SOP is for the indoor exposure only.

Probabilistic Approach of Inhalation Exposure Calculation

Both concentration and time variables are of variability type. However, using all variability type variables will not yield the 2-D results. Alternatively, the distribution parameters of any of the variability variables can be assign as uncertainty variables to enable the 2-D simulation. In this SOP, the mean and standard deviation of the time variable will be assign as uncertainty variables. First, the two parameters will be calculated from the NHEXAS database. Then the corresponding values will be obtained from other studies similar to NHEXAS. The IIT data analysis team will make comparisons and use their judgement to assign appropriate quantitative assumption for the uncertainty of the two values. When information about a parameter is limited, the assumptions often result in uniform or triangular distributions.

Therefore;

$$t_{i,j} = f(\mu_t, \sigma_t) \qquad (11\text{-}2)$$

where μ_t and σ_t are the mean and standard deviation of time variable and are assumed as uncertainty variables with a uniform or triangular distribution.

Variable List

Variable	Description
HHID	household I.D.
IH	Average time spent indoor by each respondent, hr
MEAN	mean of the average time spent indoor.
SD	standard deviation of the average time spent indoor.
C_DT	measured concentration of chlorpyrifos in indoor air with the BDL values censored using the distributional method. The unit is ng/m^3.
D_DT	measured concentration of diazinon in indoor air with the BDL values censored using the distributional method. The unit is ng/m^3.
EC_DT	exposure to chlorpyrifos in indoor air, using the concentration data with the BDL values censored using the distributional method. The unit is $(ng/m^3)(hr)$.
ED_DT	exposure to diazinon in indoor air, using the concentration data with the BDL values censored using the distributional method. The unit is $(ng/m^3)(hr)$.

Procedure

The concentration data will be censored with the Distributional Method explained in SOP#4. The procedure explained next is for estimating unweighted exposure for the data sets. Weighted exposure estimates can be obtained by using the SUDAAN program. The unweighted exposure estimates, with corresponding sampling weights, will be used as the program's inputs. The sampling weights used will be calculated and adjusted according to the processes explained in details in SOP # 9 and 10.

The procedure for the unweighted exposure estimation in this SOP is the following:

1. In **Crystal Ball**, open INHALATION EXPOSURE. Assign an assumption for each of the following variable: ***IH, MEAN, SD, C_DT,*** and ***D_DT.***
2. Assign forecast for ***EC_DT,*** and ***ED_DT***, the calculation of inhalation exposure corresponding to equation 11-1.
3. Choose the ***MEAN,*** and ***SD*** assumptions as uncertainty, and rest of them as variability. Run this model as a 2-D simulation.

Spreadsheet Format

In INHALATION EXPOSURE:

Column	Variable
1	***HHID***
2	***IH***
3	***MEAN***
4	***SD***
5	***C_DT***
6	***D_DT***
7	***EC_DT,*** calculated from ***C_DT*** × ***IH***
8	***ED_DT,*** calculated from ***D_DT*** × ***IH***